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Interim Bioventing Pilot Test Results Report for Spill Site No. 1, Building 457 Area, and USt 702

Eaker Air Force Base
Blytheville, Arkansas

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

Air Force Base Conversion Agency/OL-J
Eaker Air Force Base, Arkansas

August 1996

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900 • Denver, Colorado 80290

AQ M01-02-0226

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INTERIM BIOVENTING PILOT TEST RESULTS REPORT FOR SPILL SITE NO. 1, BUILDING 457 AREA, AND UST 702

EAKER AIR FORCE BASE

BLYTHEVILLE, ARKANSAS

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE

BROOKS AFB, TEXAS

and

AIR FORCE BASE CONVERSION AGENCY/OL-J

EAKER AFB, ARKANSAS

Prepared by:

Parsons Engineering Science, Inc.

1700 Broadway, Suite 900

Denver, Colorado 80290

August 1996

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INTERIM PILOT TEST RESULTS REPORT FOR SPILL SITE NO. 1, BUILDING 457 AREA, AND UST 702 EAKER AFB, ARKANSAS

1.0 INTRODUCTION

An initial bioventing pilot test was performed by Parsons Engineering Science, Inc. (Parsons ES) [formerly Engineering-Science, Inc. (ES)] at Spill Site No. 1 (SS1), Building 457 Area (B457 Area), and Underground Storage Tank (UST) 702 at Eaker Air Force Base (AFB), Arkansas during the period from March 18 through April 5, 1996. The proposed scope of work for these three sites was performed for Eaker Air Force Base Conversion Agency (AFBCA) and the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under contract F41624-92-D-8036, Order 0017. The purpose of this report is to describe the results of the initial pilot tests at each site and to make specific recommendations for extended testing to determine the long-term impact of bioventing on site contaminants. Descriptions of the history, geology, and contamination at the three sites are contained in the Bioventing Pilot Test Work Plan (Parsons ES, 1996). The location of each site with respect to the base is shown in Figure 1.1.

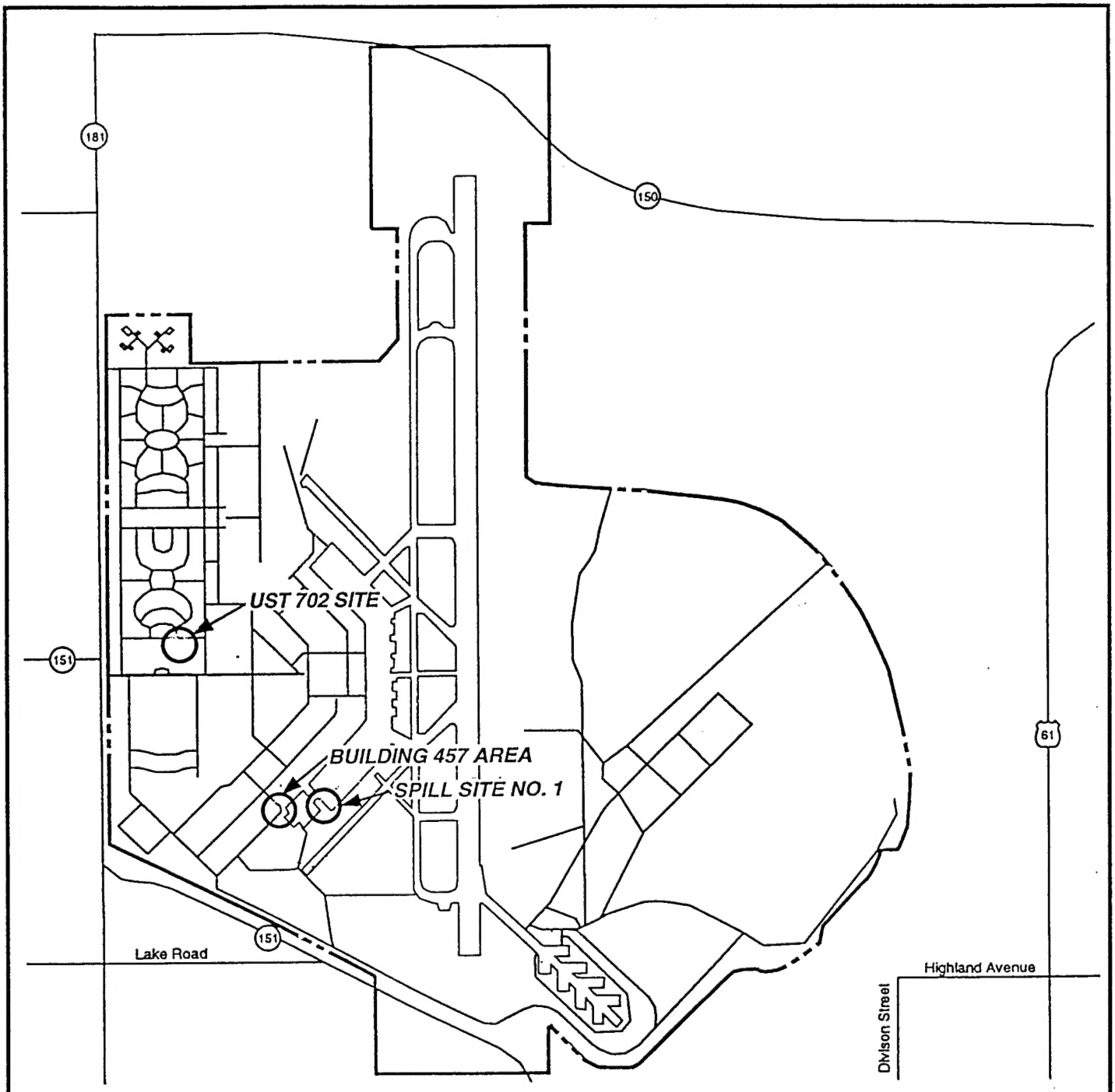
2.0 PILOT TEST RESULTS - SPILL SITE NO. 1

The source of contamination at this site was four 50,000-gallon USTs that formerly were used to store Jet-A fuel (Halliburton NUS [HNUS, 1994]). The tanks, along with a portion of grossly contaminated soils, have been removed.

2.1 Pilot Test Design and Construction

An initial bioventing pilot test was performed by Parsons ES at SS1 during the period from March 18 through April 5, 1996. A total of nine Geoprobe® boreholes were drilled at the site to better define the extent of the contamination, and to determine appropriate vapor monitoring point (MP) screen depths and optimal vent well (VW) placement. Installation of five vapor monitoring points (MPs) took place on March 20, 27, and April 4, 1996. The MPs were installed by Parsons ES in Geoprobe® boreholes. Installation of five air injection VWs took place on March 22 and 23, 1996, following MP installation and exploratory Geoprobe® drilling. The VWs were installed prior to pilot testing, and were sited based on an expected radius of oxygen influence of 30 feet. Drilling services were provided by Anderson Engineering Consultants, Inc. of Little Rock, Arkansas, and well installation and soil sampling was directed by Mr. David Teets, the Parsons ES site manager. Electrical services were provided by Cache Valley Electric of Blytheville, Arkansas.

Five VWs (VW1 through VW5), five MPs (MPA through MPE), and a blower unit were installed at SS1. Existing well MW205 also was used as a VW, and wells MW203, MW207, and MW209 were used as MPs. Figure 2.1 is a site layout showing the locations of the six VWs, eight MPs, blower unit, and other existing groundwater monitoring wells at the site. The hydrogeology of the site is depicted on the cross-



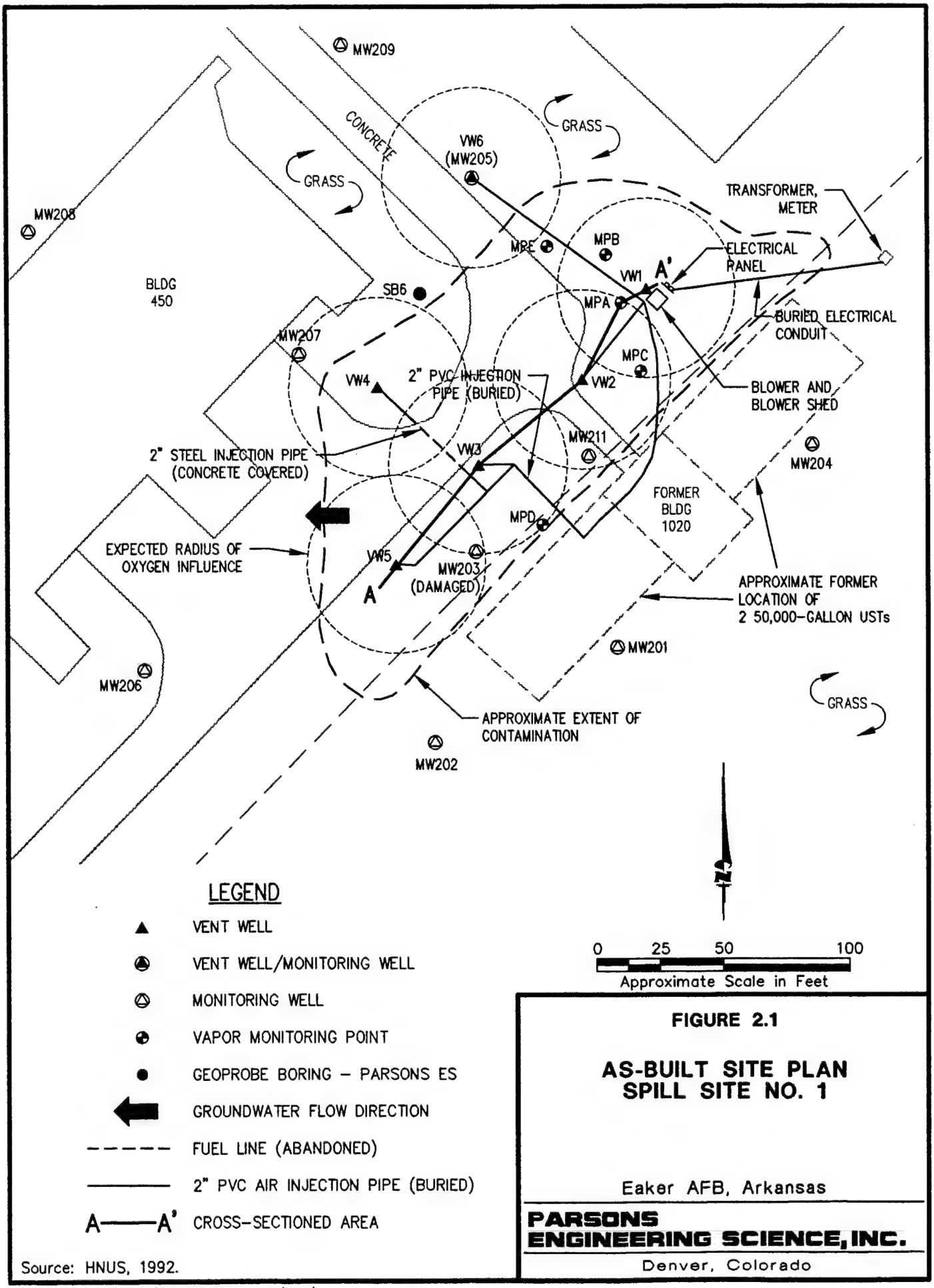
Source: US Air Force, 1995.

FIGURE 1.1

SITE LOCATIONS WITH RESPECT TO BASE

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado



Source: HNUS, 1992.

FIGURE 2.1

AS-BUILT SITE PLAN
SPILL SITE NO. 1

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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section on Figure 2.2. Boring logs for the Geoprobe® boreholes, MPs, and VWs are included in Appendix A. The background MP for this site was the existing groundwater monitoring well MW10, which is screened several feet above the groundwater surface. The following sections describe the final design and installation of the bioventing system at SS1.

2.1.1 Air Injection Vent Wells

The air injection VWs were installed in highly contaminated soils northwest of former Pumphouse No. 4 (Building 1020). The VWs were constructed using 4-inch-diameter, schedule 40 polyvinyl chloride (PVC) casing and slotted PVC screen. Table 2.1 summarizes the VW construction details. Vent wells VW3, VW4, and VW5 were constructed with two types of slotted screen to facilitate air flow through the less permeable clay layer. A bentonite seal was placed between each slotted screen type at a depth corresponding to the blank casing at the pipe joint. The top of each VW was completed with a 12-inch-diameter, flush-mounted well box mounted in a rectangular concrete pad. Details of the six VW constructions are presented on Figures 2.3 through 2.8.

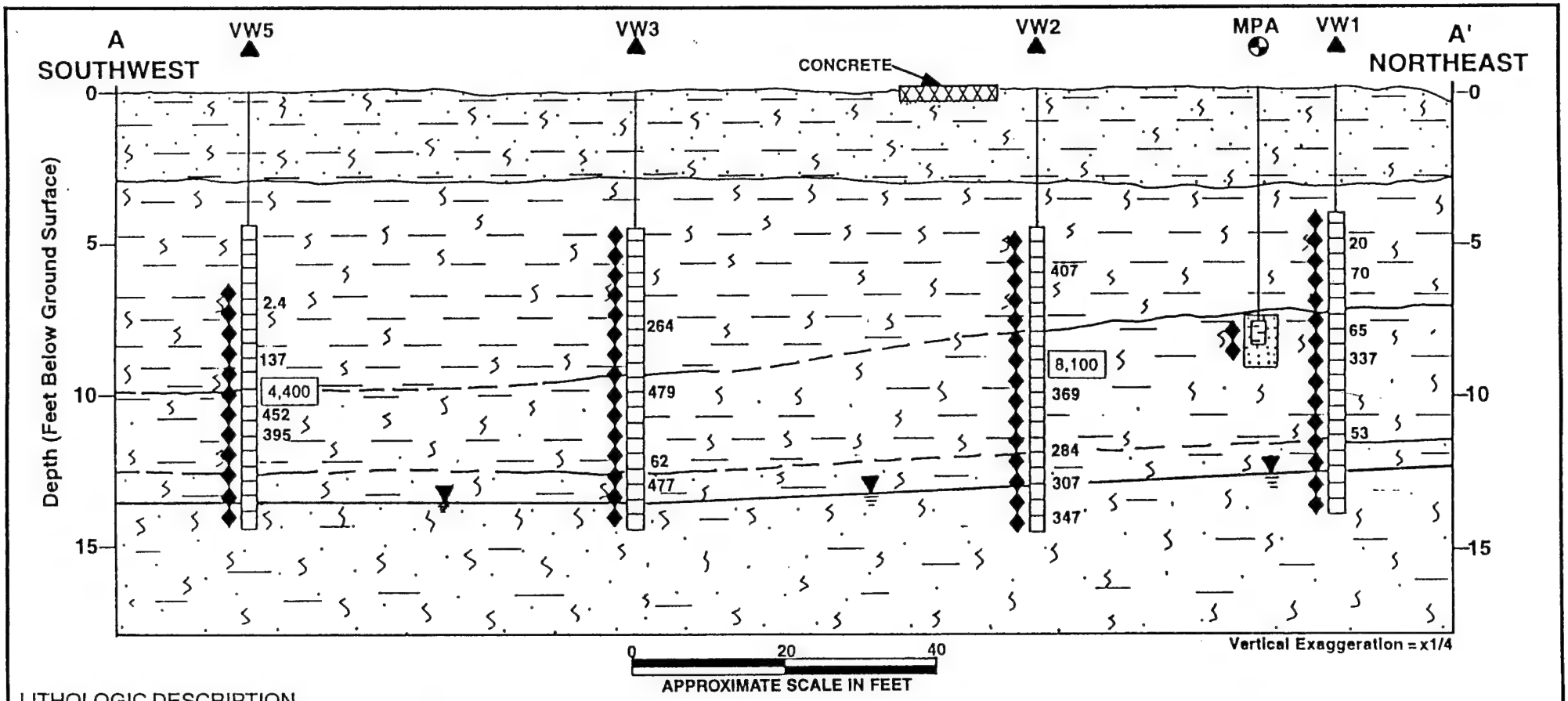
2.1.2 Monitoring Points

The MP screens were installed at the depths listed on Table 2.1. The five new MPs (MPA, MPB, MPC, MPD, and MPE) at this site were constructed as shown in Figure 2.9. Each MP, installed in Geoprobe® borings, was constructed with a 6-inch-long, 0.25-inch, outside-diameter (OD) stainless steel screen implant attached to 0.5-inch-OD, high-density polyethylene (HDPE) tubing that extends to the ground surface. The top of each 0.5-inch HDPE riser was completed with a 3/8-inch needle valve. The top of each MP was completed with a flush-mounted metal well protector set in concrete.

The existing groundwater monitoring well MW10, was used as the background MP for this pilot test. MW10 is located in an uncontaminated area approximately 1,200 feet southwest of SS1 and has a screened interval extending above the groundwater surface.

2.1.3 Blower Unit

A 3-horsepower, positive-displacement blower unit was used at SS1 for the initial pilot test, and a 2-horsepower Gast® regenerative blower unit was installed for extended testing. The blower is energized by 230-volt, single-phase, 30-amp line power from a new distribution panel located on a new electrical panel installed adjacent to VW1 (Figure 2.1). The pilot test blower injected air into the subsurface at 32.9 standard cubic feet per minute (scfm) for the initial test at VW1. The injection flow rate was optimized at 21.8 scfm for VW1, VW2, VW3, and VW4, 12.0 scfm for VW5, and 18.5 scfm for VW6 for the extended pilot test. The final blower wiring was completed and the system was started up on April 4, 1996. The configuration, instrumentation, and specifications for the initial pilot test and extended pilot test units are shown on Figure 2.10. Following the field mobilization, Parsons ES engineers provided an operations and maintenance (O&M) briefing checklist and blower



LITHOLOGIC DESCRIPTION

CLAY SILT SAND

LEGEND

- VW5 ▲ VENT WELL
- MPA ◕ VAPOR MONITORING POINT
- 137 FIELD SCREENING RESULTS FOR TOTAL VOLATILE HYDROCARBONS (ppmv)
- 4,400 LABORATORY RESULTS FOR SOIL TOTAL VOLATILE PETROLEUM HYDROCARBONS (mg/kg)
- FUEL ODOR DETECTED DURING DRILLING
- GROUNDWATER ELEVATION, DASHED WHERE INFERRED
- GEOLOGIC CONTACT, DASHED WHERE INFERRED
- MONITORING POINT SCREENED INTERVAL AND SAND PACK INTERVAL
- SCREENED INTERVAL

FIGURE 2.2

HYDROGEOLOGIC CROSS-SECTION SPILL SITE NO.1

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

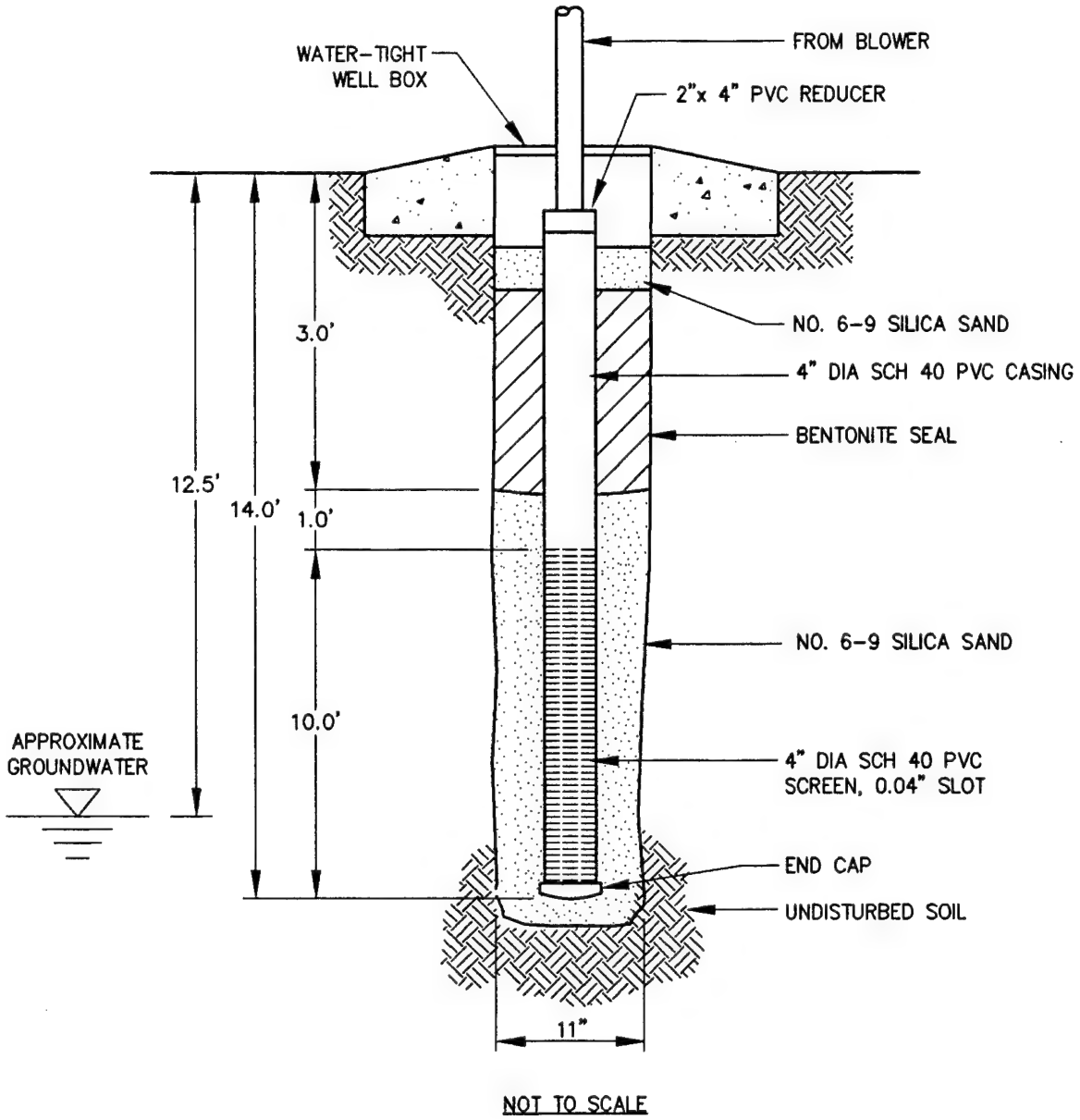
TABLE 2.1
VENT WELL AND MONITORING POINT CONSTRUCTION SUMMARY
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Location	Total Borehole Depth (feet bgs) [a/]	Screened Interval (feet bgs)
VW1	15	4-14
VW2	15	4.5-14.5
VW3	15	4.5-14.5
VW4	20	5-20
VW5	15	4.5-14.5
VW6 (MW205)	21.5	9.1-19.1
MPA	10	9
MPB	12.5	5, 8.5
MPC	11	5, 9
MPD	11	5, 9
MPE	9	9.5
MW207 [b/]	23.6	11.6-21.6
MW209 [b/]	27.5	15.5-25.5

[a/] bgs = below ground surface.

[b/] This existing monitoring well was used as a vapor monitoring point.

Note: Vent wells VW1 through VW5 were completed on March 22-23, 1996, and monitoring points MPA through MPE were completed on March 20 and 27, and April 4, 1996.



NOT TO SCALE

FIGURE 2.3

AS-BUILT
INJECTION VENT WELL (VW1)
CONSTRUCTION DETAIL
SPILL SITE NO. 1

Eaker AFB, Arkansas

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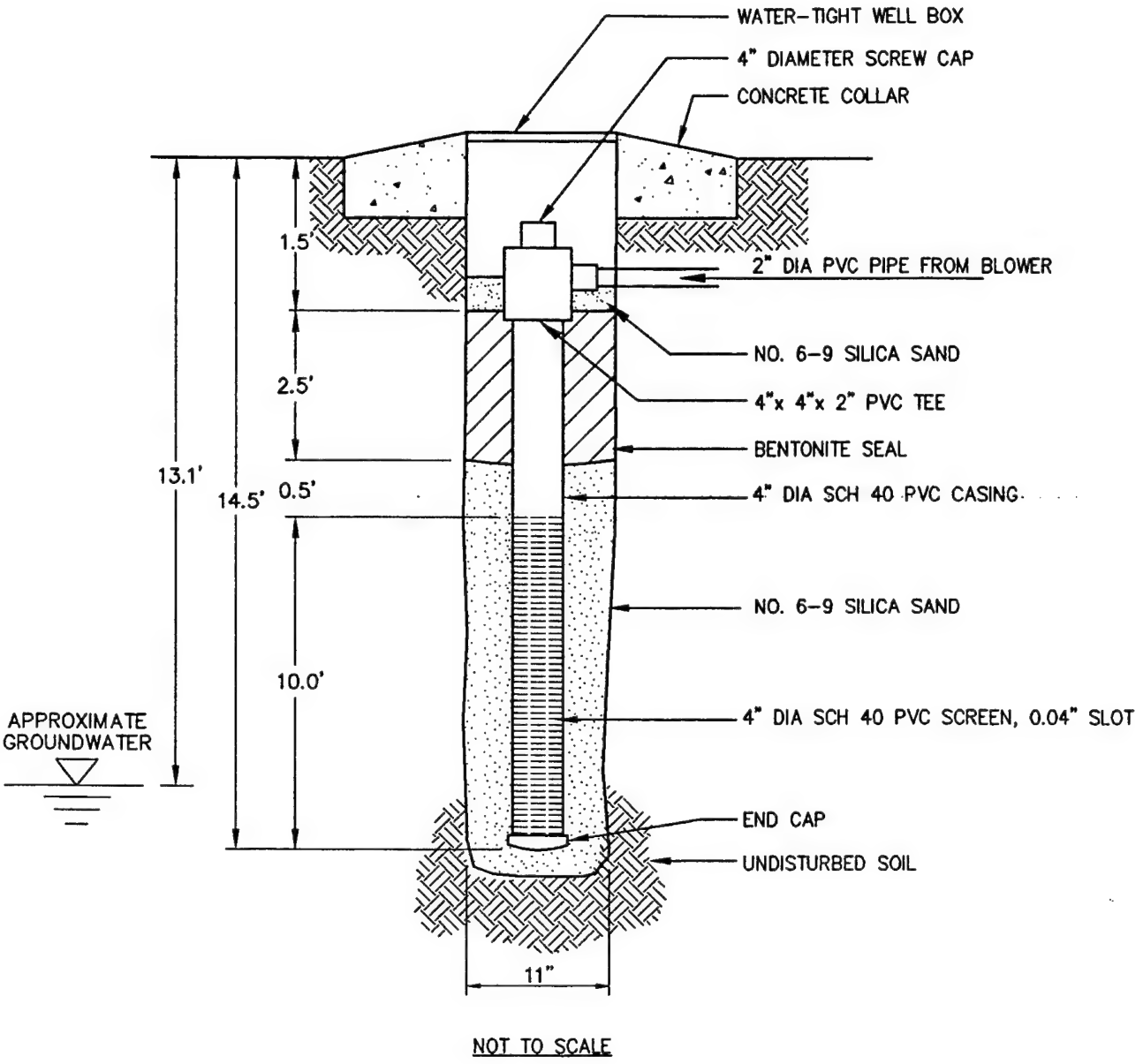
Denver, Colorado



NOT TO SCALE

FIGURE 2.4

AS-BUILT
INJECTION VENT WELL (VW2)
CONSTRUCTION DETAIL
SPILL SITE NO. 1

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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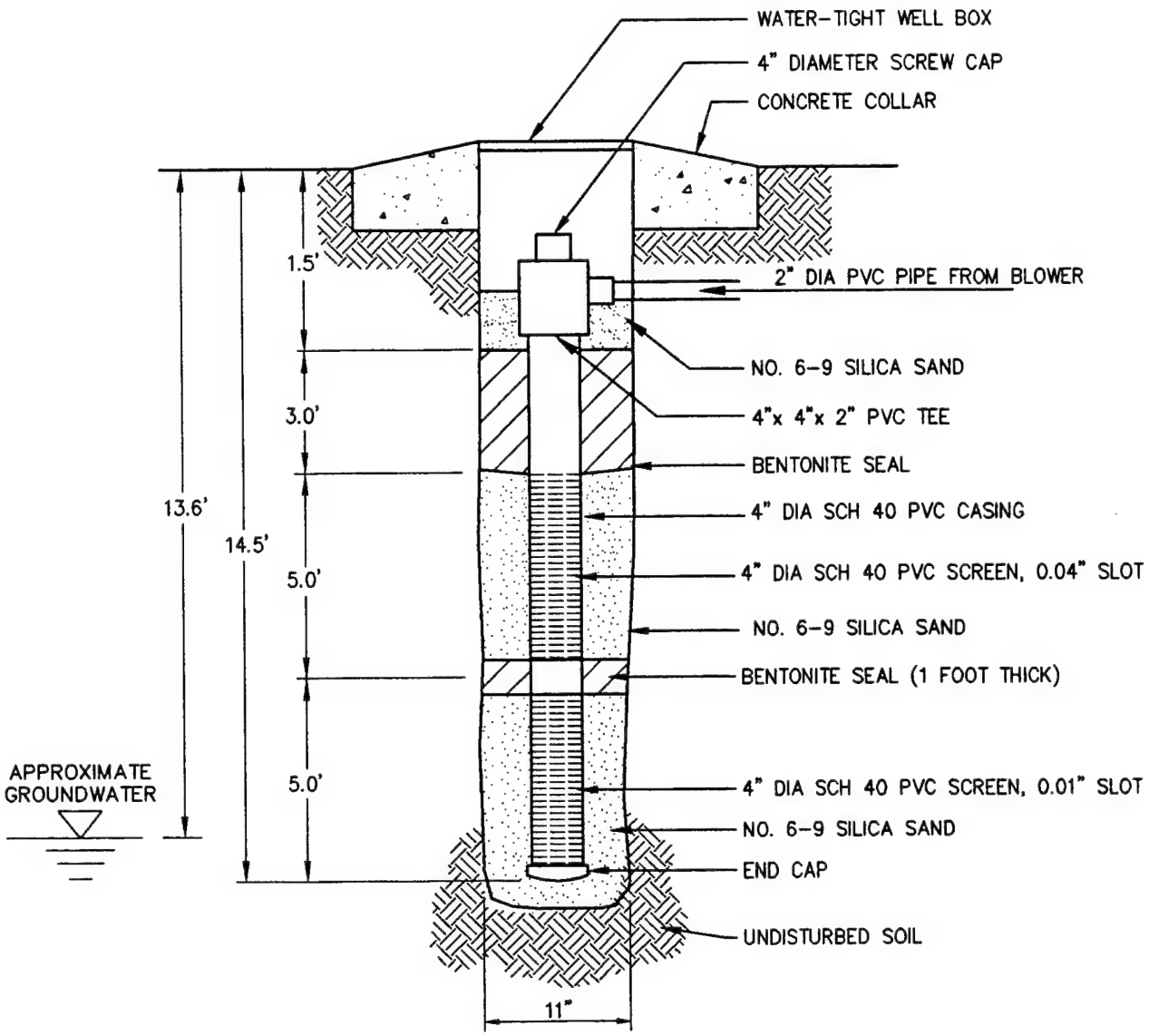

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FIGURE 2.5

AS-BUILT
INJECTION VENT WELL (VW3)
CONSTRUCTION DETAIL
SPILL SITE NO. 1

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

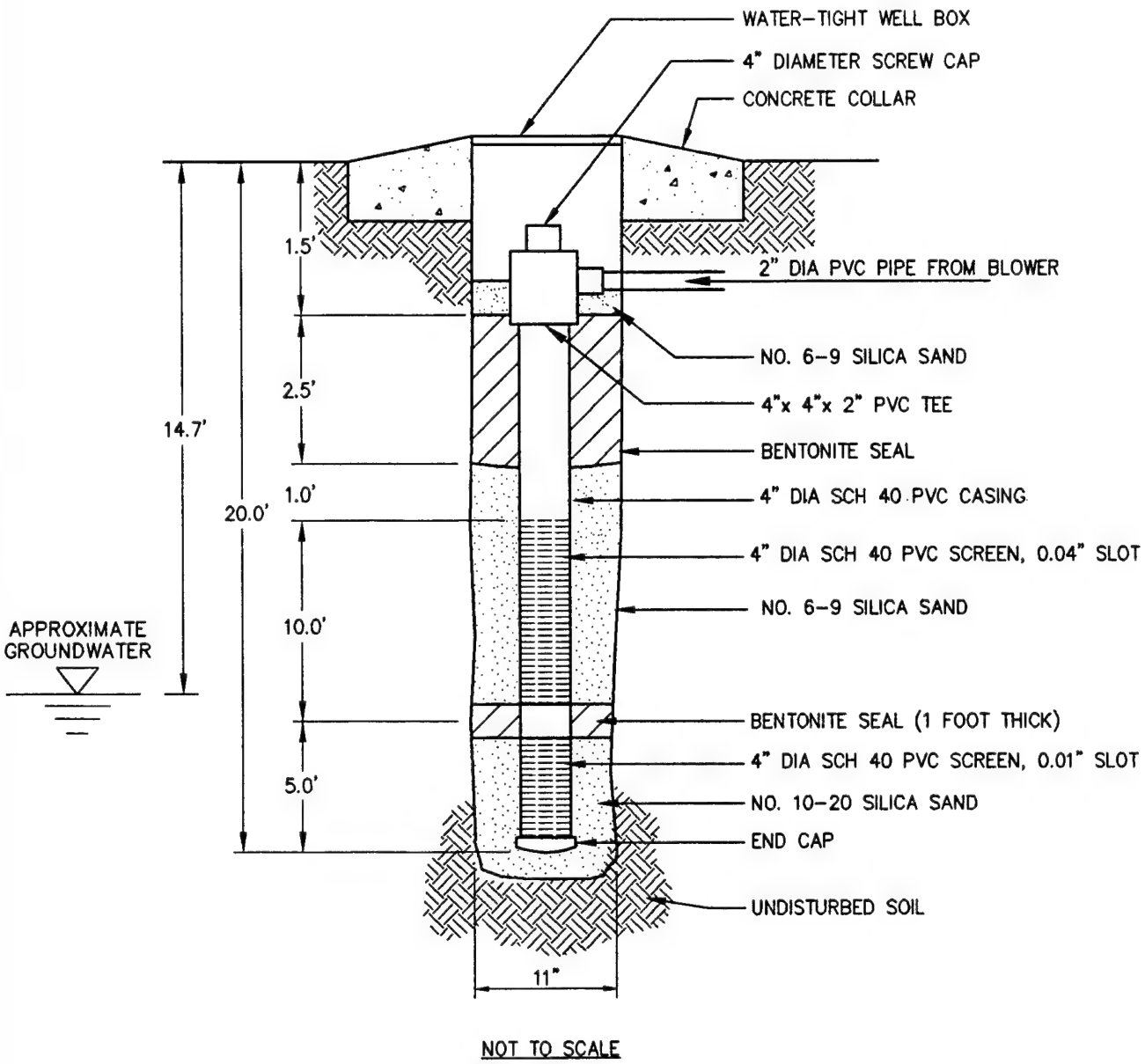

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FIGURE 2.6

AS-BUILT
INJECTION VENT WELL (VW4)
CONSTRUCTION DETAIL
SPILL SITE NO. 1

Eaker AFB, Arkansas

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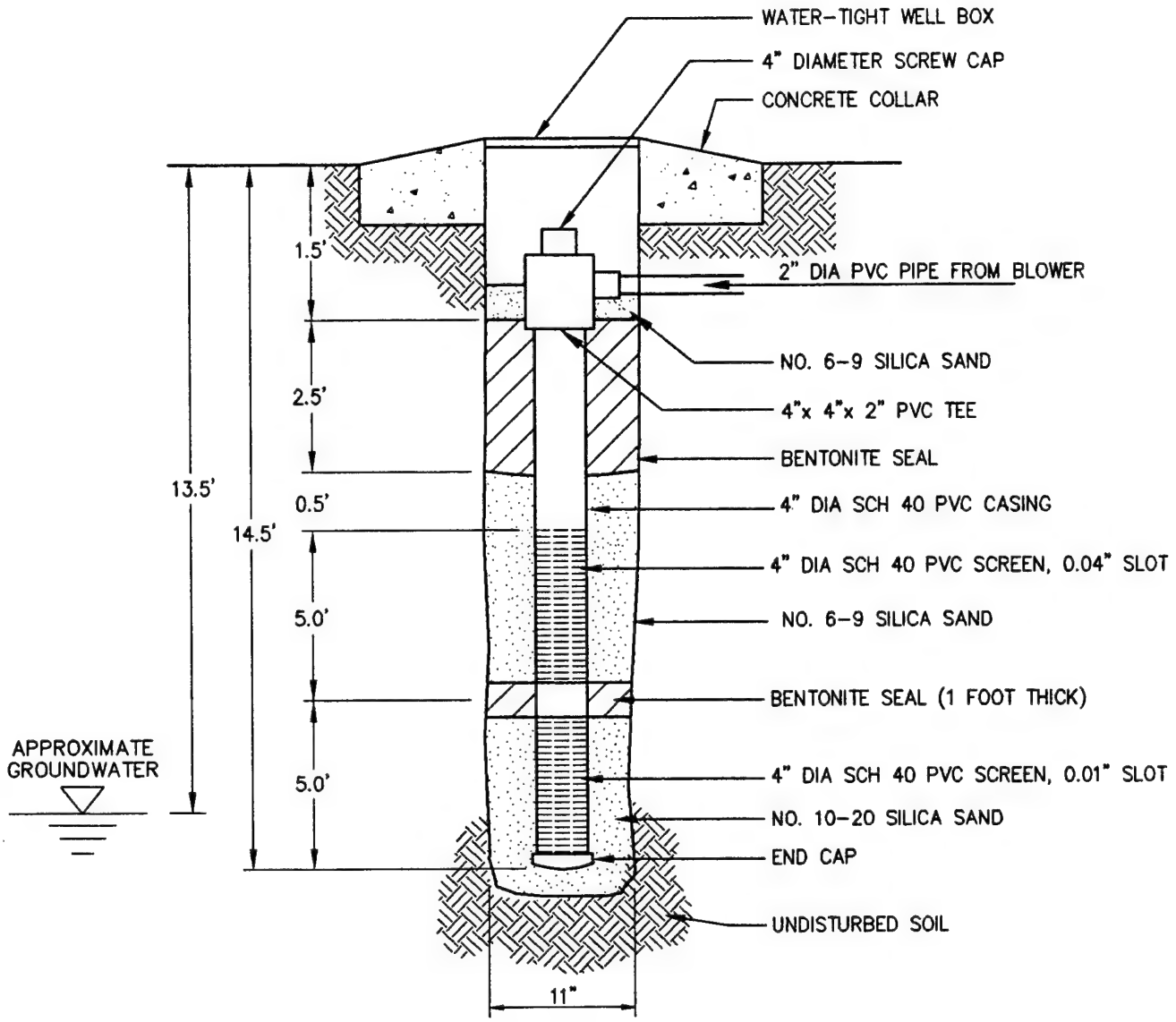

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FIGURE 2.7

AS-BUILT
INJECTION VENT WELL (VW5)
CONSTRUCTION DETAIL
SPILL SITE NO. 1

Eaker AFB, Arkansas

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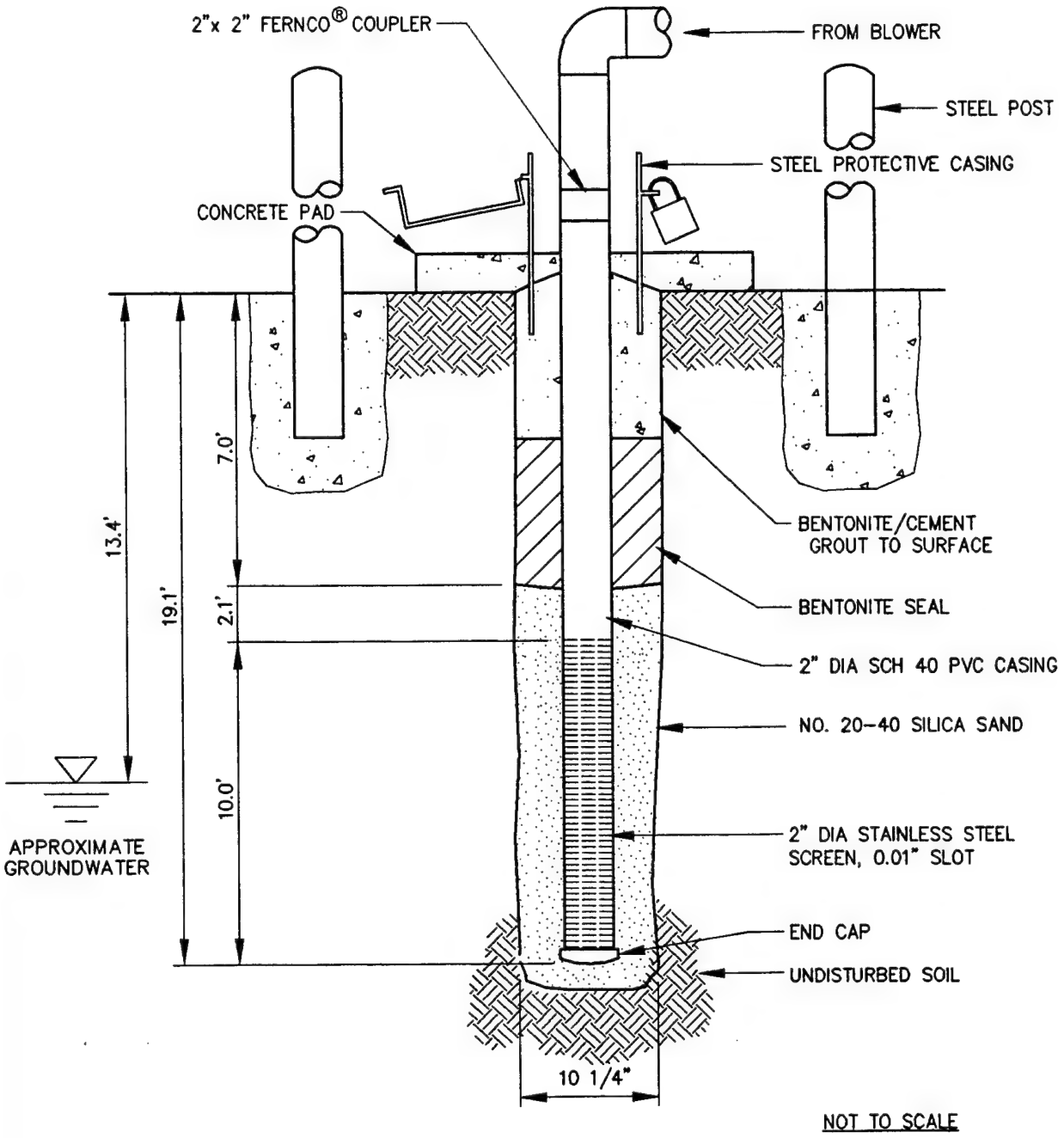
MONITORING WELL MW205



NOT TO SCALE

FIGURE 2.8

AS-BUILT
INJECTION VENT WELL (VW6)
CONSTRUCTION DETAIL
SPILL SITE NO. 1

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

Source: Halliburton NUS, 1995

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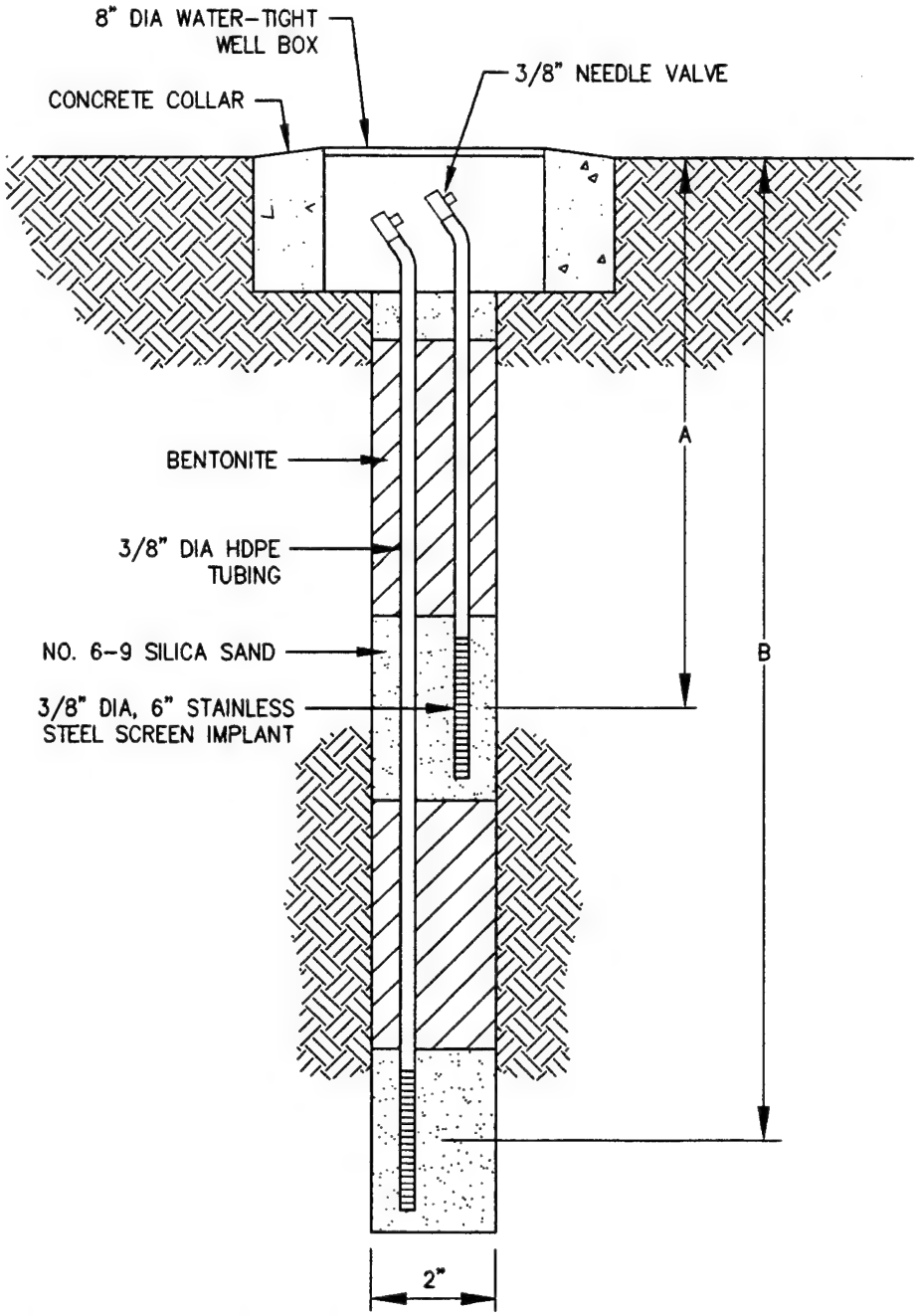


MONITORING POINT	DEPTH TO SCREENED INTERVAL (ft bgs)[a/]	
	A	B
MPA	NA[b/]	9.0
MPB	5.0	8.5
MPC	5.0	9.0
MPD	5.0	9.0
MPE	NA	9.5

a/ ft bgs = FEET BELOW GROUND SURFACE
b/ NA = NOT APPLICABLE

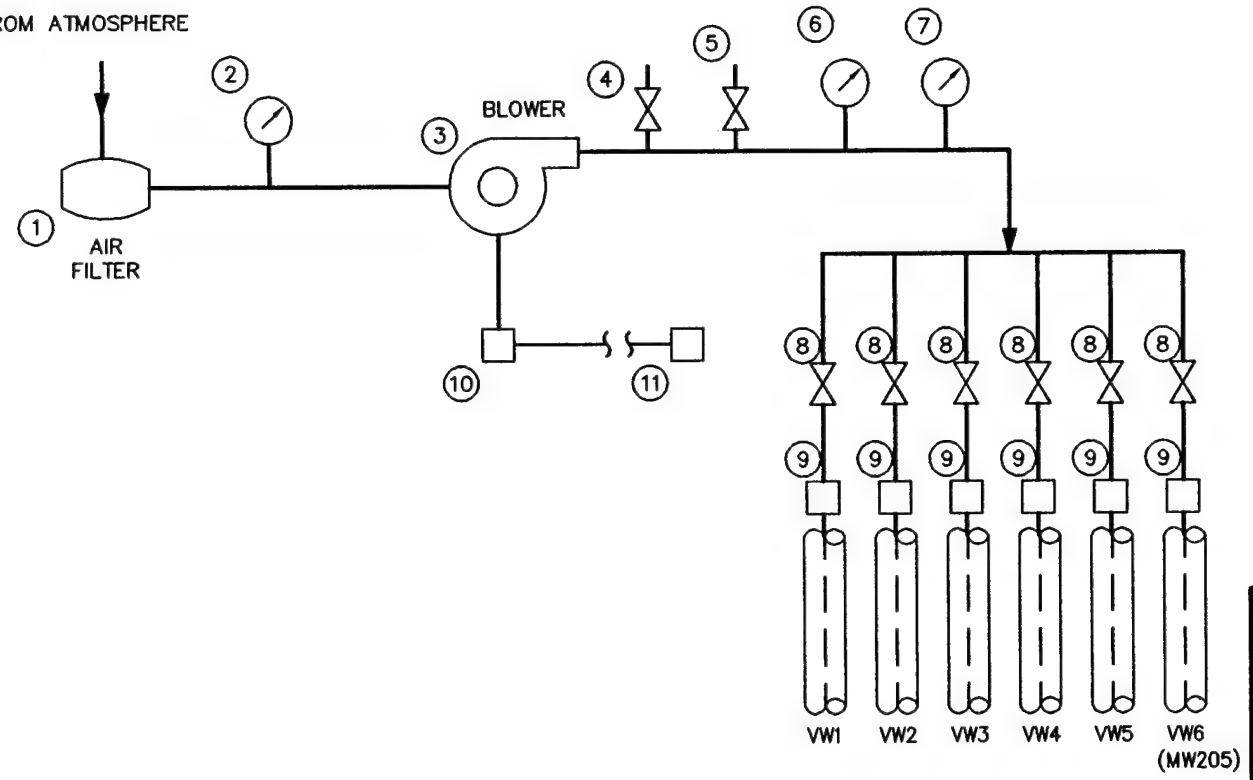
FIGURE 2.9

AS-BUILT MONITORING POINT CONSTRUCTION DETAIL (TYPICAL) SPILL SITE NO. 1

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado



LEGEND

1. INLET AIR FILTER – SOLBERG F–30P–150
2. VACUUM GAUGE (IN H_2O)
3. BLOWER – GAST® 2.5HP R5125Q–50
4. MANUAL PRESSURE RELIEF (BLEED) VALVE 1 1/2" GATE
5. AUTOMATIC PRESSURE RELIEF VALVE
6. TEMPERATURE GAUGE – (F)
7. PRESSURE GAUGE – (IN H_2O)
8. FLOW CONTROL VALVE – 1 1/2" GATE
9. FLOW MEASURING PORT FITTED WITH PLUG
10. STARTER
11. BREAKER BOX – 240V/SINGLE PHASE/40 AMP

NO SCALE

FIGURE 2.10

AS-BUILT BLOWER SYSTEM INSTRUMENTATION DIAGRAM FOR AIR INJECTION SPILL SITE NO. 1

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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maintenance manual to AFBCA personnel. A copy of the checklist is provided in Appendix C.

The 2-horsepower blower system has sufficient reserve air-flow capacity to provide air to future, additional VWs if results of 1 year of extended pilot testing indicate that additional VWs are required to remediate the entire volume of contaminated soil at this site. Additional Geoprobe® borings and MPs will be installed during the May 1997 field mobilization to confirm that the full areal extent (FAE) of contamination is being treated (Section 2.4). The excess air flow is presently being bled off using the manual gate valve (Figure 2.10).

2.2 Pilot Test Soil and Soil Gas Sampling Results

2.2.1 Sampling Results

Soils at this site consist generally of approximately 8 to 10 feet of silty clay material overlying 1 to 4 feet of clayey silt and fine-grained sand. Groundwater was measured in each VW at a depth of approximately 12.5 to 14.7 feet below ground surface (bgs) following VW construction. The groundwater surface becomes deeper in the direction of Building 450 (Figure 2.2). More detailed geological information regarding SS1 can be found in the geological cross-section (Figure 2.2) and the geologic boring logs (Appendix A).

Petroleum-hydrocarbon-contaminated soils at this site were encountered beginning at depths ranging from approximately 5 feet bgs in the VW and MP boreholes and extended to below the groundwater surface at depths between 15 and 20 feet bgs. Contaminated soils were identified based on odor, staining, and headspace volatile organic compound (VOC) field screening results. Contaminated soils were encountered in all VW and MP boreholes, with the highest contaminant concentrations occurring in VW2, MPC, and MPD boreholes. Soils at these locations had a strong hydrocarbon odor, and a gray-stained soil layer was encountered at depths between approximately 6 and 14 feet bgs in each borehole (Figure 2.2).

Seven soil samples for laboratory analysis were collected from Geoprobe® polybutyrate liners or split-spoon samplers. Soil sample headspace was screened for VOCs using a photoionization detector (PID) and a total hydrocarbon vapor analyzer (THVA) to determine the presence of contamination and to select soil samples for laboratory analysis. Soil samples for laboratory analysis were collected from depths of 9 to 11 feet bgs from VW2, VW4, VW5, MPB, MPC, and MPD boreholes. A background soil sample was collected from an apparently uncontaminated area southwest of the site, near MW10, at a depth of 2.5 feet bgs. Soil samples were shipped via Federal Express® to Evergreen Analytical Laboratory in Wheat Ridge, Colorado for chemical and physical analysis. Soil samples were analyzed for total volatile petroleum hydrocarbons (TVPH) by US Environmental Protection Agency (EPA) Method SW8015 (modified); and for benzene, toluene, ethylbenzene, and xylenes (BTEX) by EPA Method SW8020. Three samples also were analyzed for iron, alkalinity, total Kjeldahl nitrogen (TKN), and several physical parameters. The background soil sample was analyzed only for TKN. Copies of the chain-of-custody

TABLE 2.2
SOIL AND SOIL GAS ANALYTICAL RESULTS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Analyte (Units)[a/]	Sample Location-Depth (feet below ground surface)								
Soil Gas Hydrocarbons	VW2	VW3	VW4	VW6	MPA-9	MPB-8.5	MPC-9	MPD-9	MPE-9.5
TVH[b/] (ppmv)	60,000	32,000	22,000	17,000	5,900	6.6 [c/]	16,000	20,000	1,600
Benzene (ppmv)	670	230	100	74	43	0.024	110	63	34
Ethylbenzene (ppmv)	120	51	58	51	24	0.031	51	39	39
Toluene (ppmv)	190	110	130	160	48	0.070	87	92	140
Xylenes (ppmv)	120	25	71	44	50	0.27M [d/]	50	11	42

Soil Hydrocarbons	VW2-9	VW4-10	VW5-9.5	MPB-9	MPB-9.5	MPC-10	MPD-9
TVPH - Jet Fuel[e/] (mg/kg)	8,800	280	4,400	620	3,200	11,000	7,800
Benzene (µg/kg)	< 560	< 57	< 570	< 56	< 230	< 1,100	< 550
Toluene (µg/kg)	< 560	< 57	< 570	< 56	< 230	< 1,100	< 550
Ethylbenzene (µg/kg)	54,000	810	19,000	1,800	12,000	85,000	50,000
Xylenes (µg/kg)	160,000	2,000	30,000	7,600	41,000	180,000	46,000

Soil Inorganics	VW1-6.5	VW1-10	MPC-5.5	BG-2.5 [f/]
pH (pH units)	7.6	6.9	6.3	---
Iron (mg/kg)	12,100	12,600	10,600	---
Alkalinity (mg/kg)	200	< 28.0	50.3	---
TKN (mg/kg)	133	< 5.6	< 5.6	<4.6
Phosphorus (mg/kg)	< 2.1	< 2.0	< 2.1	---

Soil Physical Parameters	VW1-6.5	VW1-10	MPC-5.5
Moisture (% wt.)	10.5	11.8	10.8
Gravel (%)	0.0	0.0	0.0
Sand (%)	22.1	87.9	68.9
Fines (Silt and Clay) (%)	77.9	12.1	31.1

a/ ppmv=parts per million, volume per volume; mg/kg=milligrams per kilogram; µg/kg=micrograms per kilogram; TKN=total Kjeldahl nitrogen; TVH=total volatile hydrocarbons; TVPH=total volatile petroleum hydrocarbons; wt.=weight.
b/ TVH referenced as jet fuel and analyzed by USEPA Method TO-3.
c/ Reported value is invalid based on the elevated initial field TVH measurement.
d/ M = Reported value may be biased due to apparent matrix interferences.
e/ TVPH referenced as jet fuel and analyzed for by USEPA Method SW8015 modified.
f/ --- = Not analyzed.

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forms are included in Appendix A. The results of these analyses are provided in Table 2.2.

Nine soil gas samples for laboratory analyses were collected prior to performing the *in situ* respiration test in laboratory-provided, evacuated, 1-liter SUMMA® canisters. Soil gas samples were collected by extracting soil gas from VW2, VW3, VW4, VW6, MPA-9, MPB-8.5, MPC-9, MPD-9, and MPE-9.5. All soil gas samples were collected following procedures in the AFCEE bioventing pilot test protocol document (Hinchee *et al.*, 1992). Soil gas samples were shipped via Federal Express® to Air Toxics, Inc. in Folsom, California for total volatile hydrocarbon (TVH) and BTEX analysis by EPA Method TO-3. The results of these analyses are provided in Table 2.2.

2.2.2 Exceptions to Test Protocol Document Procedures and Work Plan

Procedures described in the protocol document (Hinchee *et al.*, 1992) were used to complete the pilot tests at SS1, except thermocouples were not installed. During the May 1997 field event a thermocouple will be installed in a newly installed MP (Section 2.4). Because the drilling requirements at B457 Area (Section 3.0) and UST 702 (Section 4.0) were less than expected, additional work was performed at SS1 to fulfill the scope of work. Four additional VWs were installed, and well MW205 was used as a VW rather than wells MW203 and MW211. Well MW203 was damaged, and well MW211 does not have enough exposed screened interval. Additional soil gas samples also were collected and analyzed to better define the extent of contamination. Vent wells VW3, VW4, and VW5 were constructed with two types of slotted screen to facilitate air flow through the less permeable upper soil interval (Figures 2.5, 2.6, and 2.7).

2.3 Pilot Test Results

2.3.1 Initial Soil Gas Chemistry

Prior to initiating any air injection, soil gas in the newly installed VWs, all MPs, and eight of the existing groundwater monitoring wells (MW201, MW202, MW203, MW204, MW205, MW207, MW209, and MW211) was analyzed for initial oxygen, carbon dioxide, and TVH concentrations using portable gas analyzers, as described in the technical protocol document (Hinchee *et al.*, 1992). Table 2.3 summarizes the initial soil gas chemistry. The VWs, MPs, and monitoring wells were purged until oxygen levels had stabilized to remove stagnant gas prior to collecting soil gas samples, and were measured.

Results indicate significant soil contamination northwest of the former tank excavation, extending to Building 450. Contamination appears to start at approximately 6 feet bgs near the northwestern edge of the former tank excavation, and extends to the groundwater at approximately 13 feet bgs. The soils appeared more grossly contaminated starting at a depth of approximately 8.5 feet bgs near the northwestern side of the former tank excavation. This depth interval corresponds to the smear zone near the water table.

TABLE 2.3
INITIAL SOIL GAS CHEMISTRY
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Sample Location	Screen Depth (feet)	O_2 (%)	CO_2 (%)	Field TVH (ppmv) [a/]	Laboratory TVH (ppmv) [b/]
VW1	4-14	2.5	8.7	>20,000	---[c/]
VW2	4.5-14.5	0.8	15.5	>20,000	60,000
VW3	4.5-14.5	0.0	19.0	>40,000	32,000
VW4	5-20	1.5	17.0	>40,000	22,000
VW5	4.5-14.5	20.8	0.4	260	---
VW6 (MW205)	9.1-19.1	3.2	19.0	>40,000	17,000
MPA	9	1.4	15.0	>20,000	5,900
MPB	5	20.4	0.1	2,000	---
MPB	8.5	2.2	12.0	>20,000	6.6 [d/]
MPC	5	20.5	0.7	4,200	---
MPC	9	2.2	12.1	>20,000	16,000
MPD	5	---[e/]	---	---	---
MPD	9	1.5	14.2	>20,000	20,000
MPE	9.5	1.3	15.2	>40,000	1,600
MW201 [f/]	7-22	9.1	8.0	1,000	---
MW202 [f/]	6.6-21.6	8.5	4.3	4,800	---
MW203 [f/]	6-21	4.2	11.2	>10,000	---
MW204 [f/]	NA	19.8	1.6	150	---
MW207 [f/]	11.5-21.5	0.0	12.0	6,000	---
MW209 [g/]	15.5-25.5	20.0	1.5	560	---
MW211 [f/]	9-19	18.9	2.3	>10,000	---

[a/] Total volatile hydrocarbon field screening results reported in parts per million, volume per volume.
[b/] Laboratory total volatile hydrocarbon analytical results referenced to jet fuel (molecular weight=156).
[c/] --- = Not analyzed.
[d/] Laboratory result is suspect based on field soil gas measurements and soil analytical results.
[e/] Monitoring point screened interval was below perched groundwater.
[f/] Sample collected during the initial site visit on November 16, 1995.
[g/] Sample collected on May 20, 1996.

At most VWs and MP screened intervals within the expected area of contamination (excluding VW5, MPB-5, MPC-5, and MW209), soil gas oxygen concentrations were significantly below the atmospheric concentration of approximately 21 percent.

Depleted oxygen concentrations indicate significant biological activity and soil contamination. The most significant oxygen depletion was measured at depths greater than 8 feet bgs at MPA, MPB, MPC, MPD, and MPE, and at VW2, VW3, and VW4 where the oxygen concentrations were at or below 2.2 percent (Table 2.3).

Initial oxygen concentrations at the 5-foot depths at MPB and MPC, and at MW209 and VW5, ranged from 20.0 to 20.9 percent. These higher soil gas oxygen concentrations coupled with lower soil gas TVH concentrations indicate less fuel contamination (and less resulting biological activity) at shallower depths and at the southwestern and northwestern edges of the contamination. However, the apparently high oxygen concentration at VW5 may be the result of forced diffusion (via the sampling pump) from cleaner soils, because only about half of the well is screened within contaminated soil. Elevated oxygen concentrations at the shallower depths also may be a result of oxygen being supplied by natural diffusion from the atmosphere and nearby uncontaminated soils. Contamination near VW4, VW5, and VW6 (MW205) appears to be confined primarily to the smear zone near the water table.

Initial TVH field measurements at the VWs and MPs ranged from 260 to >40,000 parts per million, volume per volume (ppmv), and laboratory TVH results ranged from 1,600 to 60,000 ppmv. At MPB-8.5, a laboratory result of 6.6 ppmv TVH was reported; however, based on the high TVH field measurement (>20,000 ppmv), the result is considered invalid. At the time the laboratory received sample MPB-8.5, the vacuum of the SUMMA® canister was much higher than the other samples, so it is possible that the valve may not have been functioning properly at the time of sample collection. The highest TVH concentrations were measured at depths near the smear zone (8.5-11 feet bgs), indicating significant fuel contamination. At VW5, a low field soil gas TVH value of 260 ppmv was measured (Table 2.3). However, at a depth of 9.5 to 10.5 feet bgs, soil TVPH was detected at 4,400 milligrams per kilogram (mg/kg) (Table 2.2), indicating that smear zone contamination is present near VW5.

2.3.2 Air Permeability

To obtain data more representative of the eventual bioventing conditions at SS1, air was injected into VW1 for approximately 15.5 hours prior to the air permeability test in an attempt to dry out the soils and to create air flow pathways. Conducted according to protocol document procedures, the permeability test was performed by injecting air into VW1 for 1.2 hours at a rate of approximately 33 scfm and an average pressure of 41 inches of water. The maximum pressure response at each MP is listed in Table 2.4. The pressure measured at the MPs increased gradually throughout the test. Due to the long-term, gradual pressure response, the HyperVentilate® method of determining air permeability was selected. To determine the soil gas permeability, the soil profile was evaluated as two separate intervals: 1) the upper clay interval (3 to 7 feet bgs), and 2) the lower silt and sand interval (7 to 12.5 feet bgs). Because a negligible pressure response was observed in the upper soil interval, an accurate calculated permeability value was not obtainable; however, a permeability value of >0.1 darcys, typical for

TABLE 2.4
MAXIMUM PRESSURE RESPONSE
AIR PERMEABILITY TEST
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Location	Distance From VW1 (feet)	Screen Depth (feet bgs)[a/]	Elapsed Time to Maximum Pressure (minutes)	Maximum Pressure Response (inches of water)
MPA	10.2	9	73	6.35
MPB	20.2	5	73	0.0
	20.2	8.5	73	4.9
MPC	32.8	5	52	0.03
	32.8	9	52	2.55

[a/] bgs = below ground surface.

"tight" clays, is assumed. For the lower soil interval, a soil gas permeability value of approximately 52 darcys, typical for medium sand, was calculated for this site. A radius of pressure influence of at least 33 feet was observed at depths greater than 8 feet. At MPC-9, the measuring point farthest from VW1 at a distance of 33 feet, the maximum pressure response was 2.5 inches of water.

2.3.3 Oxygen Influence

The radius of oxygen increase in the subsurface resulting from air injection into the VWs during pilot testing is the primary design parameter for full-scale bioventing system design. Optimization of full-scale and multiple-VW systems require pilot testing to determine the volume of soil that can be oxygenated at a given flow rate and VW screen configuration.

Table 2.5 presents the changes in soil gas oxygen levels that occurred during a 15.5-hour air injection period (using the pilot test blower) and a 46-day injection period (4/5/96 through 5/20/96) using the extended pilot test blower unit. Upon departure from the site on April 5, 1996, the air flow rates ranged from approximately 17.5 to 31.6 scfm at the six VWs; however, a significant air leak from VW6 had developed in the pipe trench near the blower shed sometime before April 30, 1996. This leak would have affected each of the VW's flow rates. On May 20, 1996, Parsons ES remobilized to the site to perform oxygen influence measurements and to repair the air leak. With the exception of MPB and MW203 (which is damaged), this period of air injection at vent wells VW1 through VW5 produced noticeable increases in soil gas oxygen levels at all MPs. Soil gas monitored at MW203 and the 8.5-foot depth interval at MPB showed decreases in oxygen concentrations, indicating that the soil gas was migrating outward from the area of higher contamination near vent wells VW1, VW3, and VW5 into the area of lesser contamination near MPB and MW203. Slight increases in oxygen concentrations were observed at MPE (centrally located approximately 40 feet from both VW1 and VW6) and MW207 (located 22 feet from VW4); however, monitoring during the extended 1-year pilot test will better define the effective treatment radius.

Based on measured changes in oxygen levels, it is anticipated that the radius of oxygen influence for a long-term bioventing system at this site will exceed 35 feet at depths below 6.5 to 9 feet bgs. Considering that a slight increase in oxygen concentration was observed at VW2 (43.8 feet from VW1) following 16 hours of air injection at VW1 with the pilot test blower, the radius of oxygen influence may exceed 44 feet at depths below 6.5 to 9 feet bgs. The clay soil interval above 6.5 to 9 feet bgs provides a "cap" that enhances the radius of oxygen influence in the deeper soils and minimizes VOC emissions to the surface. Currently, there are no discrete MP intervals located in oxygen-deficient soils in the upper clay interval, so it is difficult to estimate the radius of oxygen influence in the "tight" clays. During the May 1997 field event, additional multi-depth vapor MPs will be installed to monitor each soil interval and to more precisely determine the effective treatment area. Details of the proposed additional work is described in Section 2.4.

TABLE 2.5
INFLUENCE OF AIR INJECTION AT VWs ON
MONITORING POINT OXYGEN CONCENTRATIONS
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Location	Distance From VW1 (feet)	Distance From Next Nearest VW (feet)	Screen Depth (feet bgs) [a/]	Initial O_2 [b/] (%)	Final O_2 [c/] (%)	Final O_2 [d/] (%)
VW2	43.8	53.0 (from VW3)	4.5-14.5	0.8	1.2	---[e/]
MPA	10.2	34.8 (from VW2)	9	1.4	7.7	17.8
MPB	20.2	50.0 (from VW2)	8.5	2.2	1.5	1.0
MPC	32.8	23.0 (from VW2)	9	2.2	4.2	18.1
MPD	---	29.3 (from VW3)	9	1.5	---	12.3
MPE	41.9	40 (from VW6)	9.5	1.3	---	1.6
MW203	---	32 (from VW5) 33 (from VW3)	6-21	4.2[f/]	---	1.1
MW207	---	22 (from VW4)	11.6-21.6	0.0[f/]	---	1.0

[a/] bgs = below ground surface.
[b/] Measurements taken prior to respiration testing and air injection at the VWs.
[c/] Measurement taken after approximately 16 hours of air injection at VW1.
[d/] Measurements taken following approximately 46 days of air injection at the VWs (VW6 was leaking).
[e/] --- = Not sampled.
[f/] Sample collected during the initial site visit on November 16, 1995.

2.3.4 *In Situ* Respiration Rates

Following the 16-hour air injection period and the 1.2-hour permeability test at VW1 with the pilot test blower, an *in situ* respiration test was performed by injecting a mixture of air (oxygen) and approximately 7-percent helium (inert tracer gas) into three MP screened intervals (MPA-9, MPB-8.5, and MPC-9) and ambient air into VW2 and MPD-9 for a 16-hour period using 1-cubic-foot-per-minute (cfm) pumps. Oxygen loss and other changes in soil gas composition over time were then measured at these intervals. Oxygen, TVH, carbon dioxide, and helium were measured for a period of approximately 24 hours following air injection. The measured oxygen losses were then used to calculate biological oxygen utilization rates. The results of *in situ* respiration testing for VW2, MPA-9, MPB-8.5, MPC-9, and MPD-9 are presented in Figures 2.11 thro gh 2.15, respectively. Table 2.6 provides a summary of the oxygen utilization and fuel degradation rates.

Because helium is a conservative, inert gas, the change in helium concentrations over time can be useful in determining the effectiveness of the bentonite seals between MP screened intervals. Figures 2.12 through 2.14 compare oxygen utilization and helium retention. Because the observed helium losses were negligible, and because helium will diffuse approximately three times faster than oxygen due to oxygen's greater molecular weight, the measured oxygen loss is the result of bacterial respiration and not due to diffusion away from the MPs. Additionally, the area near MPA, MPB, MPC, and VW2 was somewhat oxygenated from the air injection at VW1 with the pilot test blower unit.

Oxygen loss measured at VW2 and all MP intervals occurred at high rates, ranging from 0.97 percent per hour at VW2 to 1.25 percent per hour at MPC-9. At MPC-9, the oxygen level dropped from 19.5 percent to 1.6 percent in 23 hours.

Based on these oxygen utilization rates, an estimated 1,560 to 2,010 milligrams (mg) of fuel per kilogram (kg) of soil can be degraded each year at this site. This conservative estimate is based on an average air-filled porosity of approximately 0.05 liter per kg of soil, and a ratio of 3.5 mg of oxygen consumed for every 1 mg of fuel biodegraded. Actual degradation rates may exceed these estimates.

2.3.5 Potential Air Emissions

The long-term potential for VOC air emissions from full-scale bioventing operations at this site is considered low because of the age and type of the site contaminants (greater than 5 years, and primarily JP-4 fuel); the very low air injection flow rates (12 to 21.8 scfm); the relatively impermeable clay soil overlying the clayey silt and fine-grained sand; and the nearby concrete cover. The majority of the injected air is flowing through soils below 7 feet bgs (Figure 2.2). Emissions should be minimal because accumulated vapors will move slowly outward from the air injection points and will be biodegraded as they move horizontally through the clayey silt and fine-grained sand layer. To confirm this, a GasTech® total hydrocarbon vapor analyzer will be used to monitor the breathing zone during the April 1997 field event. During pilot testing at SS1, health and safety monitoring of ambient air was not conducted because the windy

FIGURE 2.11
INITIAL RESPIRATION TEST RESULTS AT VW2
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

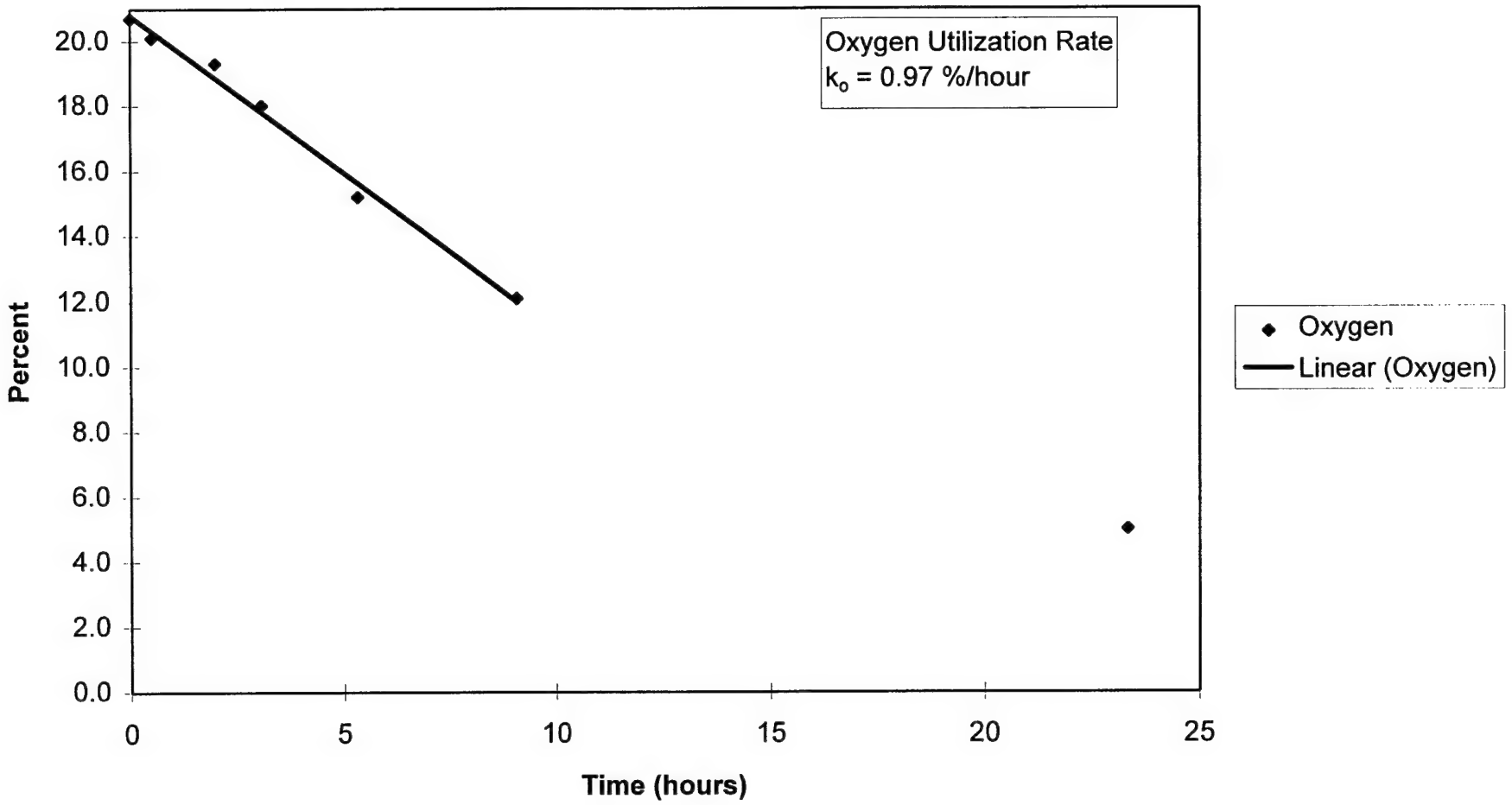

FIGURE 2.12
INITIAL RESPIRATION TEST RESULTS AT MPA-9
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

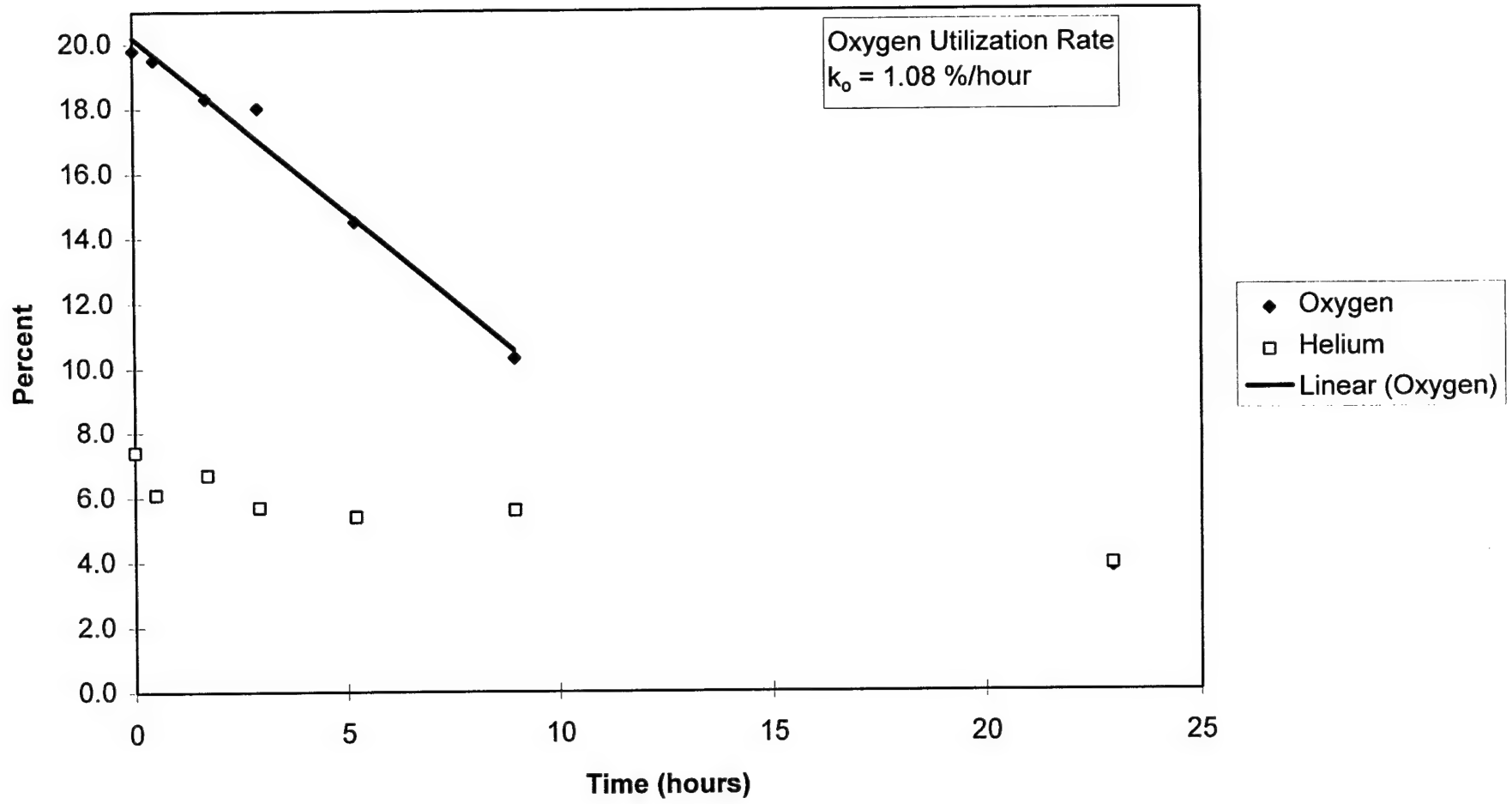

FIGURE 2.13
INITIAL RESPIRATION TEST RESULTS AT MPB-8.5
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

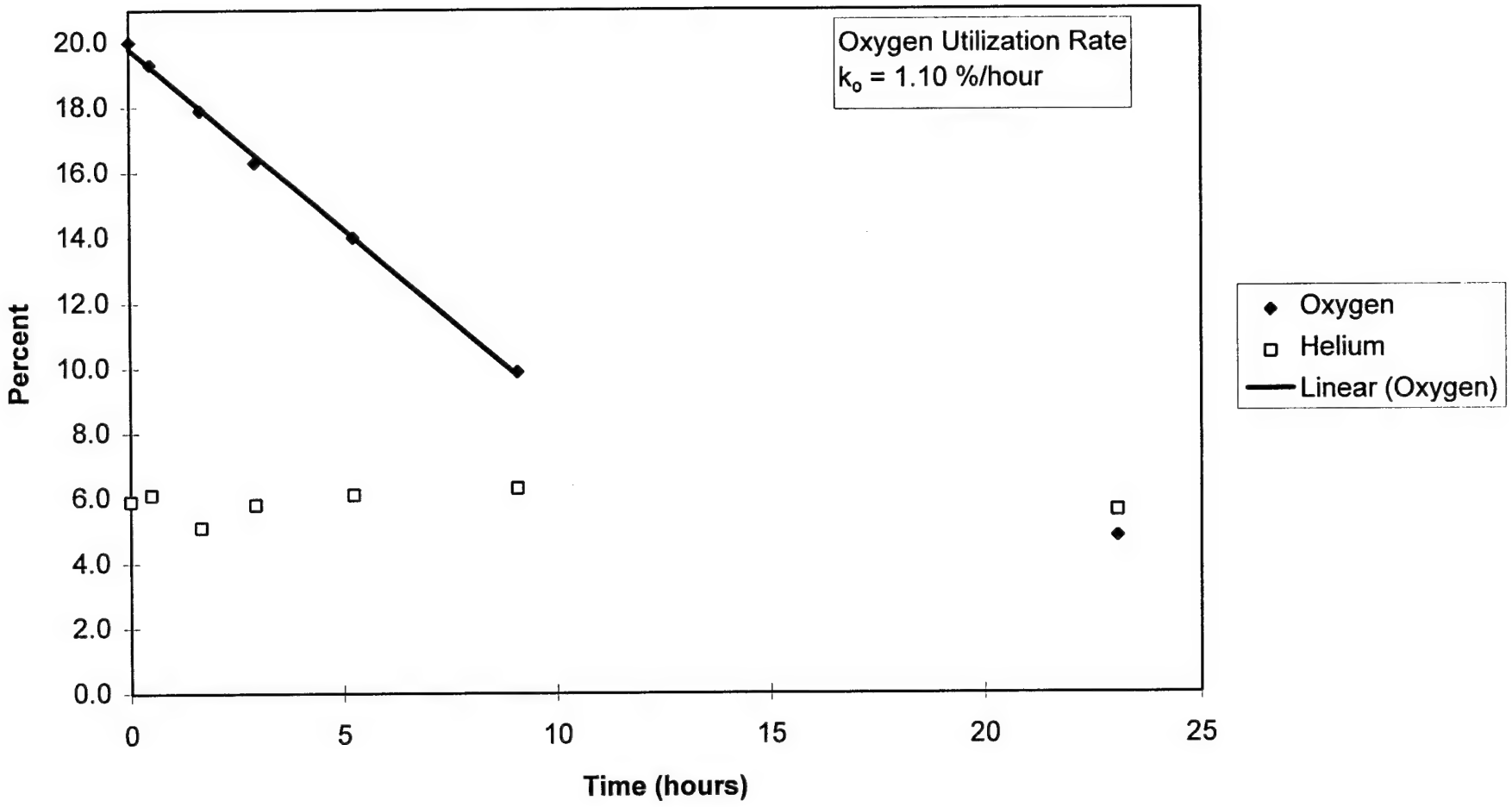

FIGURE 2.14
INITIAL RESPIRATION TEST RESULTS AT MPC-9
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

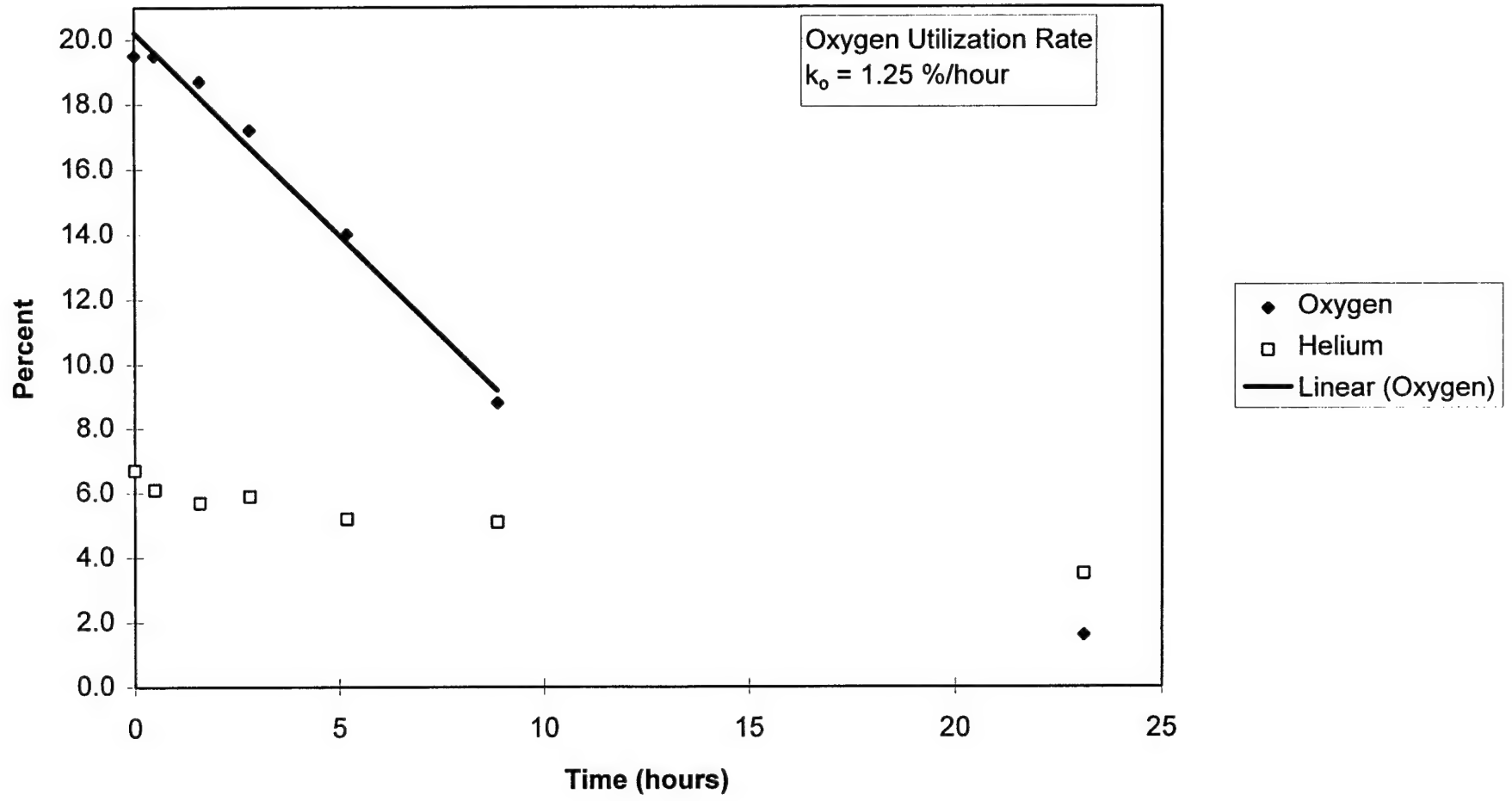

FIGURE 2.15
INITIAL RESPIRATION TEST RESULTS AT MPD-9
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

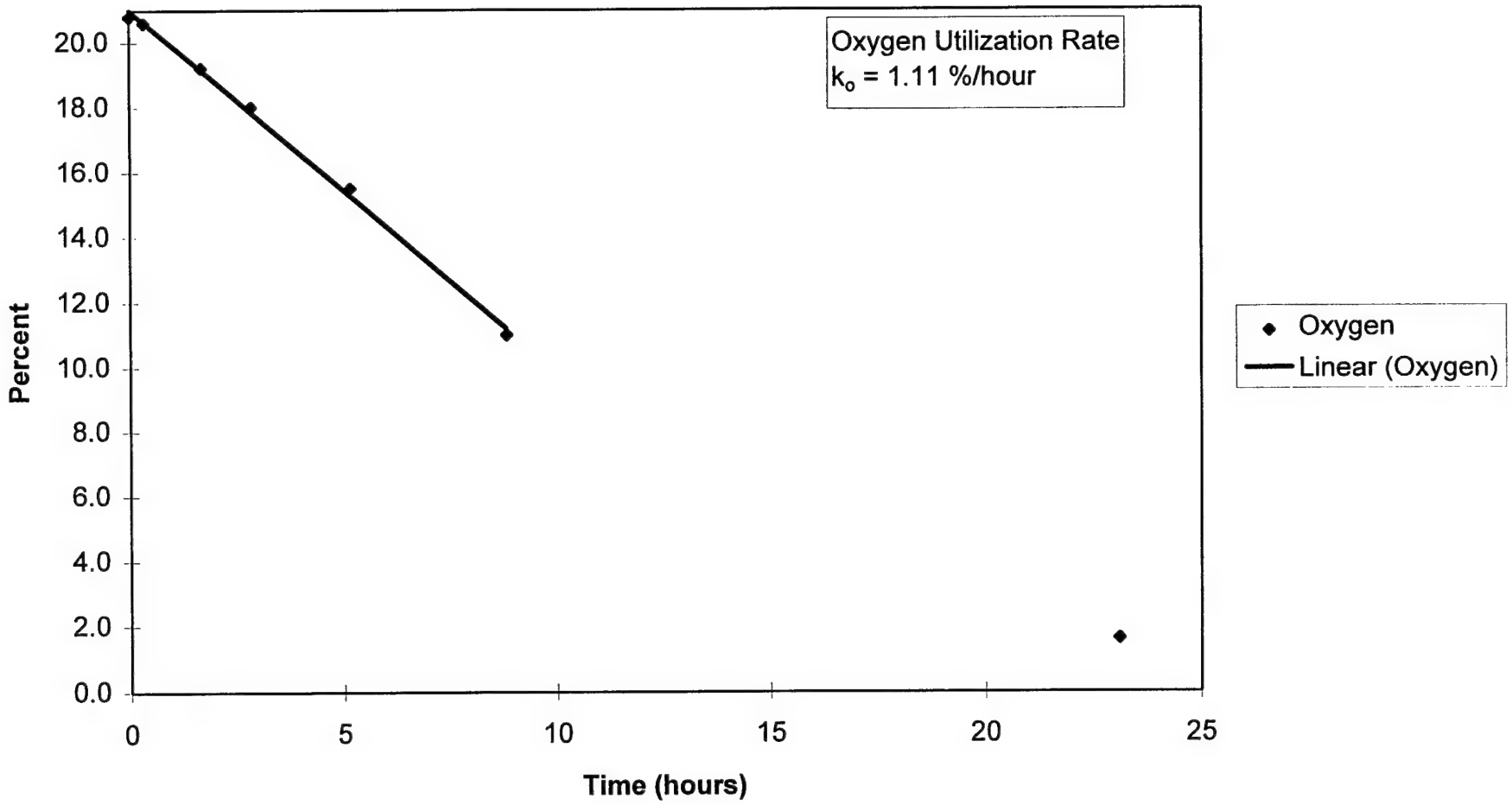

TABLE 2.6
OXYGEN UTILIZATION AND FUEL DEGRADATION RATES
SPILL SITE NO. 1
EAKER AFB, ARKANSAS

Location-Depth (feet bgs) [a/]	Test Duration (hours)	0_2 Loss (%)	O_2 Utilization Rate [b/] (%/hour)	Fuel Degradation Rate (mg TPH/kg/year)[c/]
VW2 4.5-14.5	9.1	8.6	0.97	1,560
MPA-9	9.0	9.5	1.08	1,740
MPB-8.5	9.1	10.1	1.10	1,775
MPC-9	8.9	10.7	1.25	2,010
MPD-9	8.8	9.8	1.11	1,790

[a/] bgs = below ground surface.
[b/] Values based on best-fit lines (Figures 2.11 through 2.15).
[c/] mg TPH/kg/year = milligrams of total petroleum hydrocarbons degraded per kilogram of soil per year.

conditions that would have provided biased results. Finally, the site is very isolated on Eaker AFB, and is located several thousand feet from any permanently occupied building.

2.4 Recommendations

Initial bioventing tests at this site indicate that oxygen has been depleted in the contaminated soils, and that air injection is an effective method of increasing aerobic fuel biodegradation in the more permeable soil layer. Monitoring results after the first 46 days of extended testing indicate that the radius of influence exceeds 33 feet at a depth of 8 to 11 feet bgs. It is recommended that air injection continue at this site to determine the long-term radius of oxygen influence and the effects of time and available nutrients on fuel biodegradation rates.

A small, 2-horsepower regenerative blower has been installed at the site to continue air injection. The injection flow rates were optimized at 21.8 scfm for VW1, VW2, VW3, and VW4, 12.0 scfm for VW5, and 18.5 scfm for VW6 for the extended pilot test. The 1-year test period funded under Option 1 of the Extended Bioventing Project began on April 5, 1996. Parsons ES will operate the blower through April 7, 1997, conduct radius of oxygen influence measurements on April 7, 1997, shut off the blower and then conduct follow-up "area" respiration tests. Approximately 1 month later (May 1997), Parsons ES will mobilize the Geoprobe® rig to the site to perform additional soil sampling and MP installation. Figure 2.16 shows the proposed additional Geoprobe® boring and MP locations at SS1. In addition, during the May 1997 field event, Parsons ES will collect soil gas samples from the nine points that were sampled during the initial sampling event (Table 2.2) to determine the levels of cleanup achieved after 1 year of *in situ* treatment.

The current pilot-scale bioventing system appears to be treating most of the vadose zone contamination at SS1; however, one or more VWs may be required to treat the entire volume of contaminated soil. Based on results of soil gas surveys conducted by HNUS in 1991 and 1992, areas outside the current area of venting influence may have some residual vadose zone and smear zone contamination (HNUS, 1992). Appendix B contains a summary of the soil gas survey. Oxygen influence measurements taken at the end of 1 year of system operation will be used to determine the actual radius of influence and to assess the need for additional VWs. In particular, additional VWs may be required near MPE, MW202, and near the northern edge of the former tank excavation.

Based on a high field TVH measurement (4,800 ppmv) at MW202 and data from the soil gas surveys, another VW may be required near the southwestern edge of the former tank excavation. During May 1997, Parsons ES will install three additional multi-depth MPs near MW202 and VW5 to assess the need to utilize MW202 as an additional VW. Additional multi-depth MPs will be installed and constructed in the same manner as MPB, MPC, and MPD (Figure 2.9); a thermocouple will be installed in one of these MPs. Also, based on the soil gas surveys, some untreated soils may remain near the northern edge of the former excavation. Soil gas sample E224 indicated that high levels of VOCs are present near the northern edge of the former tank excavation (HNUS, 1992). If the actual radius of oxygen influence is less than 40

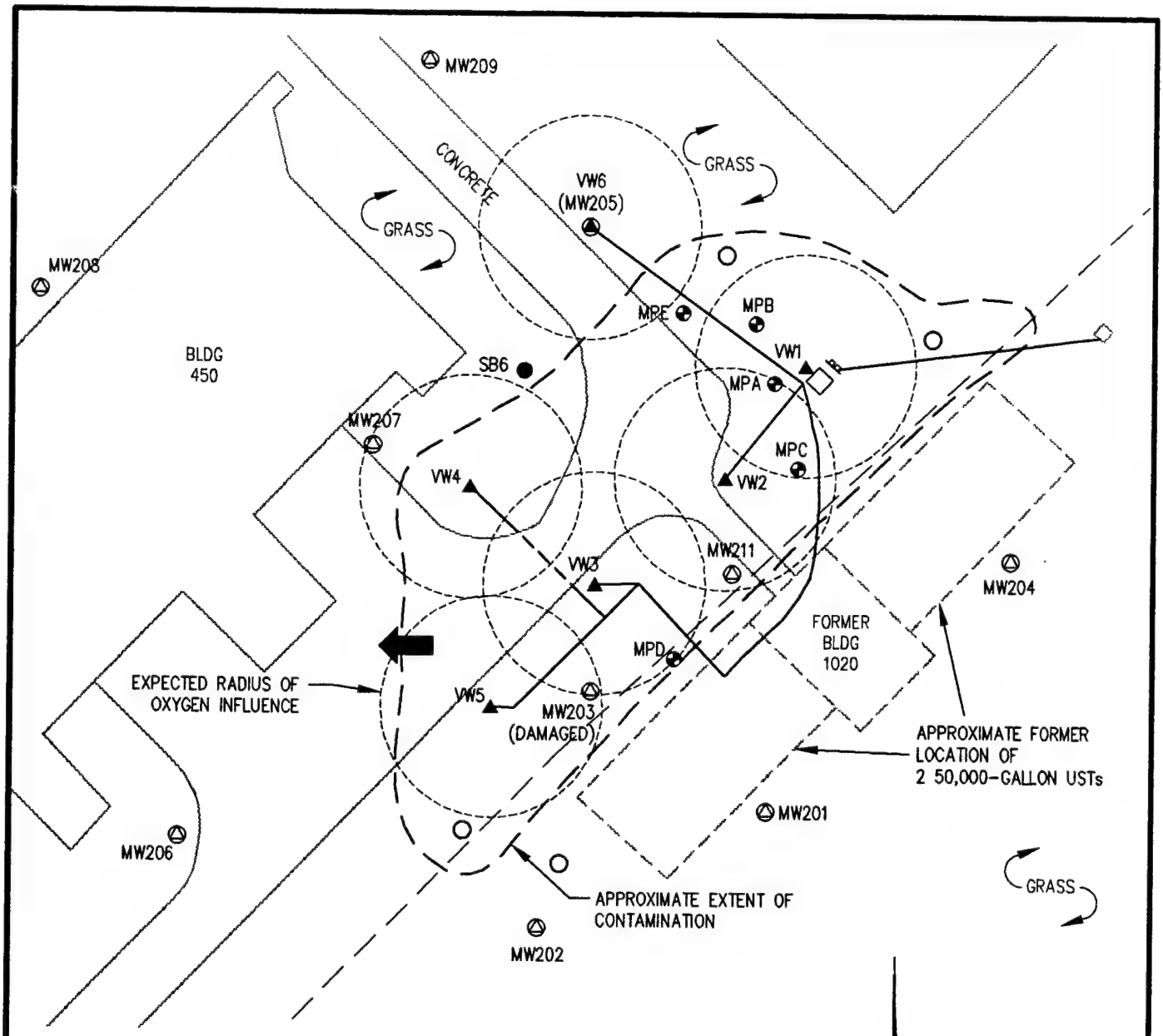

FIGURE 2.16

PROPOSED GEOPROBE BORING AND MP INSTALLATION LOCATIONS SPILL SITE NO. 1

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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feet, it is expected that another VW will be required to treat soils near MPE. A multi-depth MP will be located approximately 25 feet northeast of MPE to further delineate the FAE of contamination. Soil and soil gas samples will be collected for laboratory analysis from this MP. It is anticipated that an additional 6 soil samples and 5 soil gas samples will be collected for laboratory analyses from proposed Geoprobe® borings/MPs.

Data from over 120 Air Force bioventing sites indicate that BTEX compounds are preferentially biodegraded over total recoverable petroleum hydrocarbons (TRPH). Because BTEX compounds are among the most toxic and mobile fuel constituents, a BTEX soil cleanup standard typically is a risk-based standard. Within the AFCEE Risk-Based Petroleum Hydrocarbon "Tool Box", the report entitled "Using Risk-Based Standards will Shorten Cleanup Time at Petroleum Contaminated Sites" summarizes the BTEX/TRPH issue and will assist Eaker AFBCA in negotiating a BTEX cleanup standard. Available information indicates that the Arkansas Department of Pollution Control and Ecology (ADPC&E) requires cleanup to BTEX and TPH clean-up levels. This decision is made in conjunction with the results from a risk evaluation on a site-by-site basis. In conclusion, a risk-based approach to soil remediation (i.e., one in which BTEX is targeted for remediation) likely will expedite site closure while reducing overall costs and being protective of human health and the environment.

In general, quantitative destruction of BTEX will occur over a 1- to 2-year bioventing period. Soil gas surveys and respiration tests can be used as indicators of BTEX destruction. If a non-risk-based/TPH cleanup is chosen, the full-scale bioventing system should be operated until respiration rates approach background rates. Parsons ES recommends that confirmatory soil sampling be conducted 4 to 6 months after background respiration rates are approached.

3.0 PILOT TEST RESULTS - BUILDING 457 AREA

The source of contamination at this site was a 20,074-gallon UST formerly used to store diesel fuel oil. The tank, along with the majority of grossly contaminated soil has been removed (Ogden, 1995).

3.1 Pilot Test Design and Construction

An initial bioventing pilot test was performed by Parsons ES at the B457 Area during the period from March 18 through April 5, 1996. A total of six Geoprobe® boreholes were drilled at the site to better define the extent of the contamination, and to determine appropriate vapor MP screen depths and locations and optimal (VW) placement. Because the petroleum contamination at B457 Area is localized, two existing monitoring wells were used as VWs. Installation of three single-depth vapor MPs took place on March 18 and 19, 1996. The MPs were installed in Geoprobe® boreholes. Electrical services were provided by Cache Valley Electric of Blytheville, Arkansas.

Three MPs, a blower unit, and air injection piping to two monitoring wells were installed at Building 457 Area. Existing well TW1502 also was used as a MP. Figure 3.1 is a site layout showing the locations of the monitoring wells (TW1501 and TW1503) used for air injection, MPs, blower unit, and other existing groundwater monitoring wells at the site. The hydrogeology of the site is depicted on the cross-section on Figure 3.2. Boring logs for the MPs and VWs are included in Appendix A. The background MP for this site was existing groundwater monitoring well MW10, which is screened several feet above the groundwater surface. MW10 is located approximately 1,000 feet southeast of Building 457. The following sections describe the final design and installation of the bioventing system at the B457 Area.

3.1.1 Air Injection Vent Wells

Existing temporary groundwater monitoring wells TW1501 (VW2) and TW1503 (VW1) are being used as VWs at B457 Area. The wells were installed in oxygen-deficient soils north and south of the former tank excavation. The VWs are constructed of 2-inch-diameter, schedule 40 PVC casing and slotted PVC screen. Table 3.1 summarizes the well construction details. Details of the VW constructions are presented on Figures 3.3 and 3.4.

3.1.2 Monitoring Points

The single-depth MP screens were installed at the depths listed on Table 3.1. The three MPs (MPA, MPB, and MPC) at this site were constructed as shown in Figure 3.5. Each MP, installed in Geoprobe® borings, was constructed with a single 6-inch-long, 0.25-inch-OD stainless steel screen implant attached to 0.5-inch-OD, HDPE tubing that extends to the ground surface. The top of each 0.5-inch HDPE riser was completed with a 3/8-inch needle valve in a flush-mounted metal well protector set in concrete.

The existing groundwater monitoring well MW10, was used as the background MP for this pilot test. MW10 is located in an uncontaminated area approximately 1,000 feet southeast of Building 457 and has a screened interval extending above the groundwater surface.

3.1.3 Blower Unit

A 1-horsepower Gast® regenerative blower unit was used for the initial pilot test and was installed for extended testing. The blower is energized by 460-volt, three-phase, 15-amp line power from a new distribution panel located on a new electrical panel installed on the power pole adjacent to VW1 (Figure 3.1). The pilot test blower injected air into the subsurface at 11.5 scfm for the initial test at VW1, and the air injection flow rate for each VW was optimized at 14.7 scfm for the extended pilot test. The final blower wiring was completed, and the system was started on April 2, 1996. The configuration, instrumentation, and specifications for the initial pilot test and extended pilot test units are shown on Figure 3.6. Following the field mobilization, Parsons ES engineers provided an O&M briefing checklist and blower maintenance manual to AFBCA personnel. A copy of the checklist is provided in Appendix C.

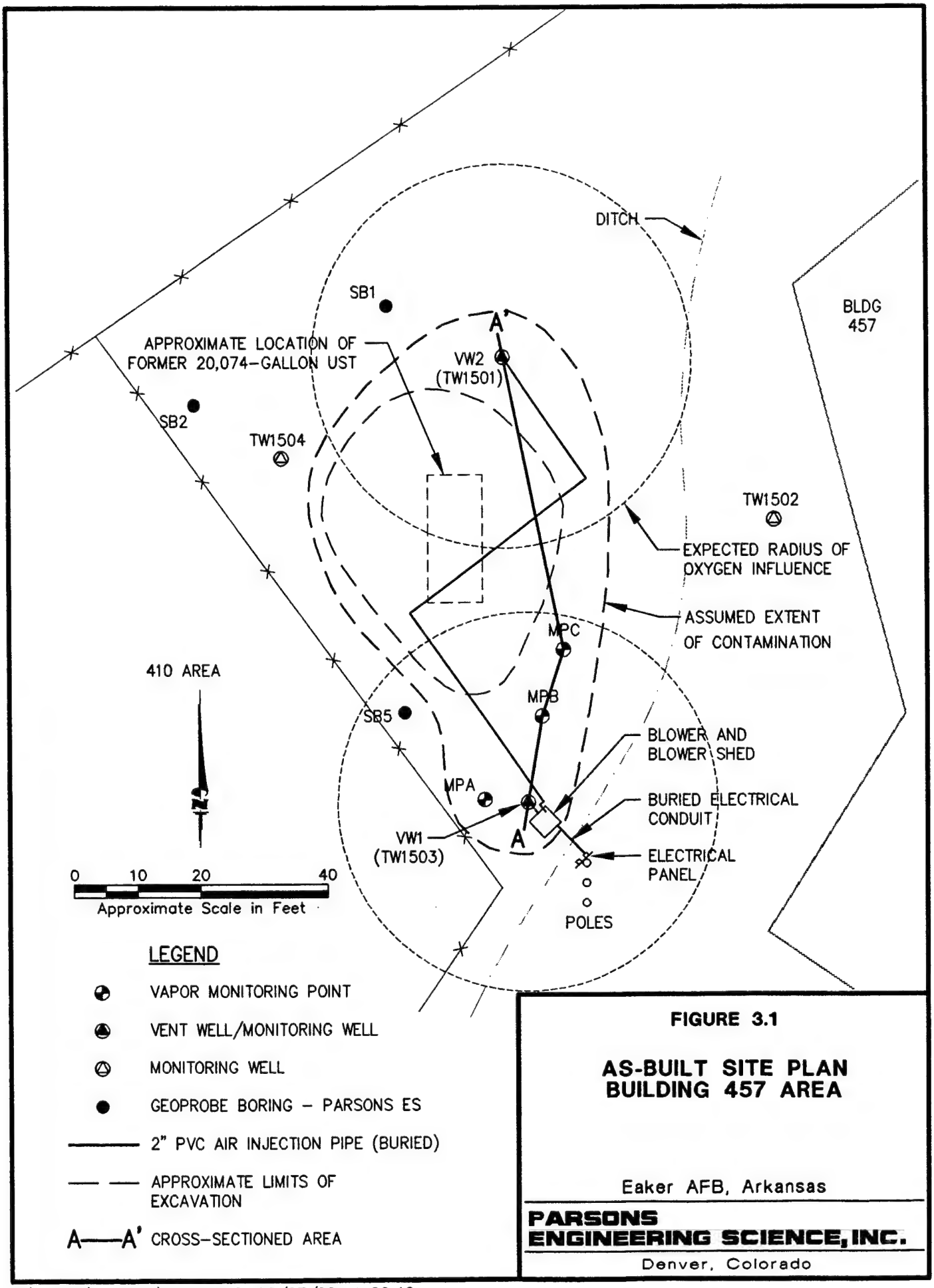

FIGURE 3.1

AS-BUILT SITE PLAN
BUILDING 457 AREA

Eaker AFB, Arkansas

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

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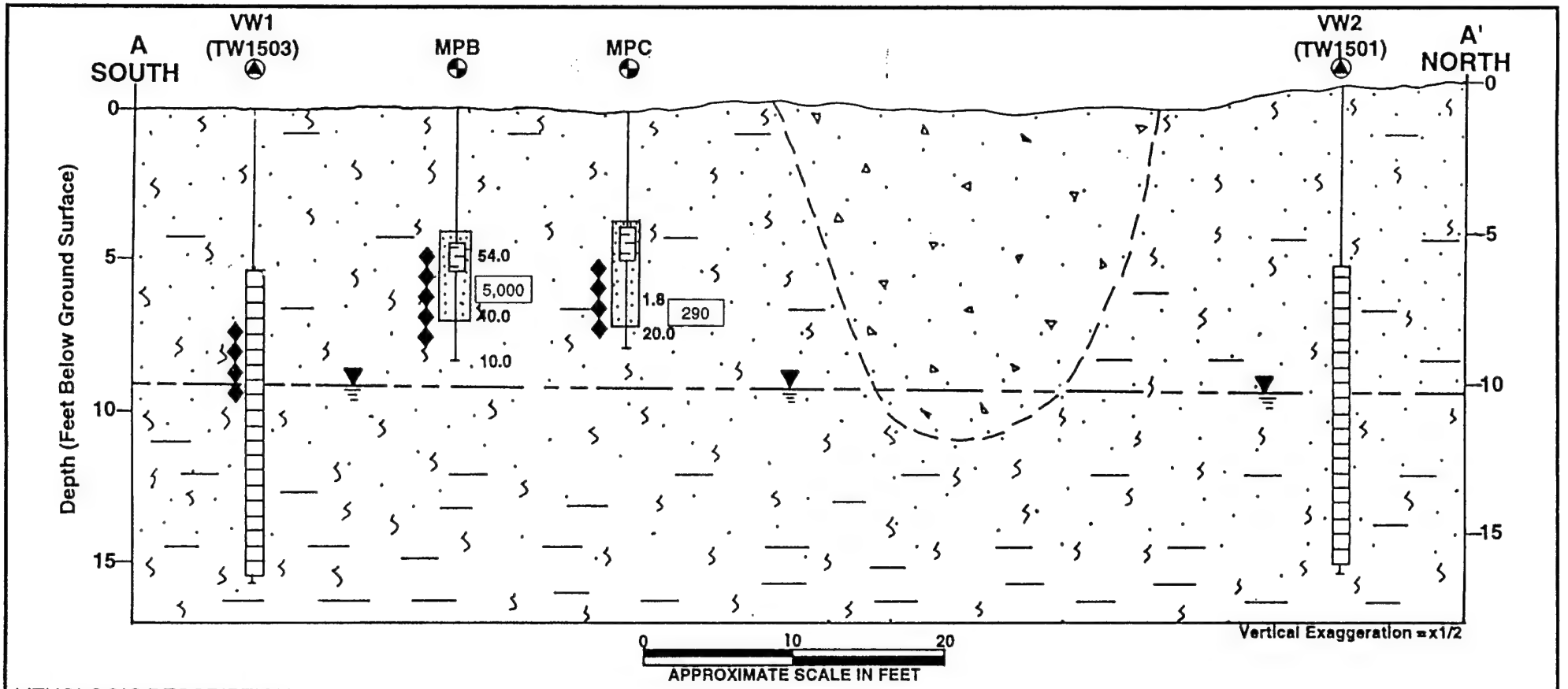

LITHOLOGIC DESCRIPTION

CLAY | SILT | SAND | BACKFILL

LEGEND

- VW1 (TW1503) — VENT WELL/MONITORING WELL
- MPB — VAPOR MONITORING POINT
- 54.0 — FIELD SCREENING RESULTS FOR TOTAL VOLATILE HYDROCARBONS (ppmv)
- 5,000 — LABORATORY RESULTS FOR SOIL TOTAL EXTRACTABLE PETROLEUM HYDROCARBONS (mg/kg)
- FUEL ODOR DETECTED DURING DRILLING
- GROUNDWATER ELEVATION, DASHED WHERE INFERRED
- GEOLOGIC CONTACT, DASHED WHERE INFERRED
- MONITORING POINT SCREENED INTERVAL AND SAND PACK INTERVAL
- SCREENED INTERVAL

FIGURE 3.2

HYDROGEOLOGIC CROSS-SECTION BUILDING 457 AREA

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

TABLE 3.1
VENT WELL AND MONITORING POINT CONSTRUCTION SUMMARY
BUILDING 457 AREA
EAKER AFB, ARKANSAS

Location	Total Borehole Depth (feet bgs) [a/]	Screened Interval (feet bgs)
VW1 (TW1503)	16	5.5-15.5
VW2 (TW1501)	16.5	6-16
MPA	9	5.5
MPB	8.5	5
MPC	7.5	4.5

[a/] bgs = below ground surface.

Note: The monitoring points were completed on March 19, 1996.

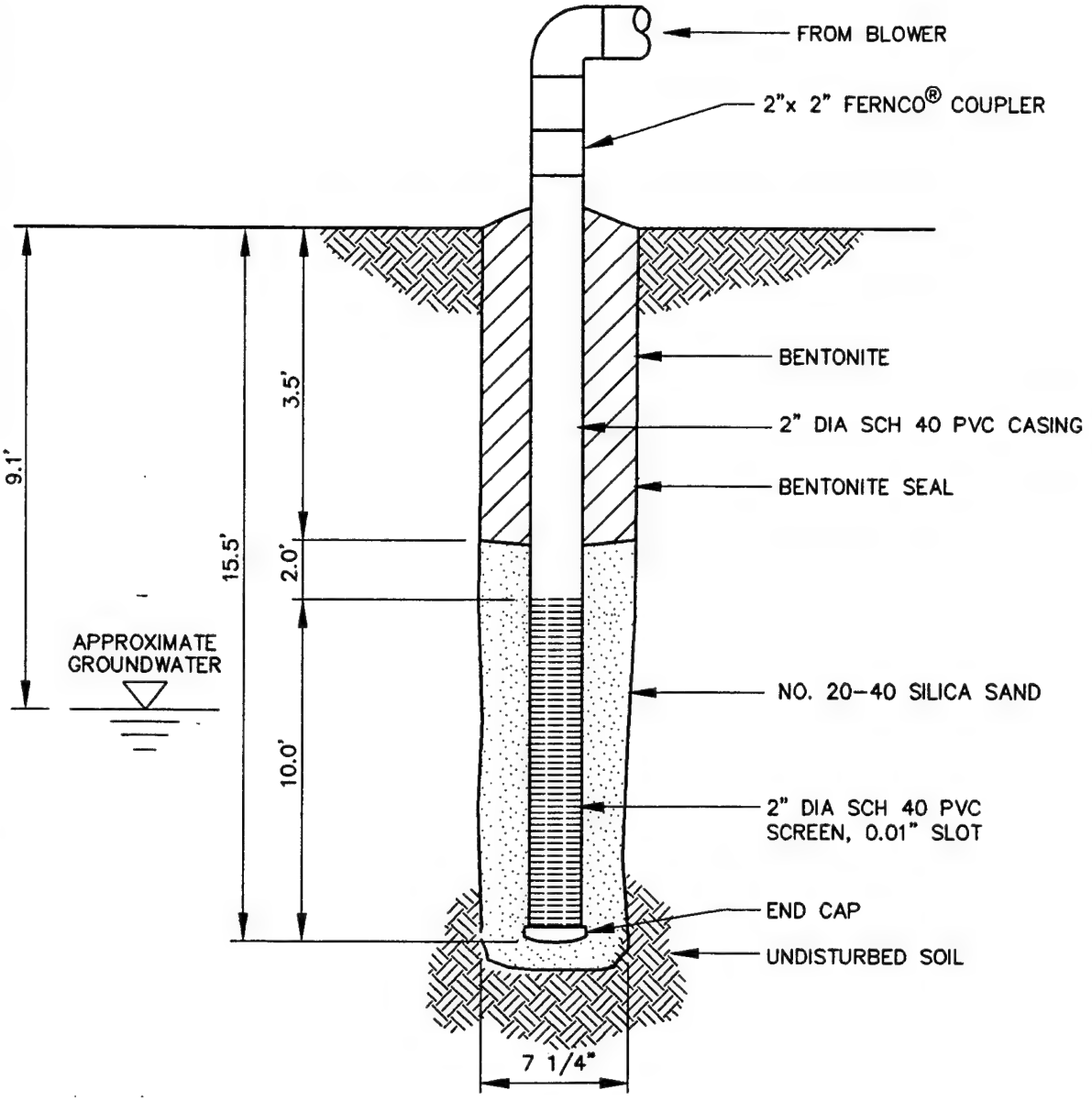

FIGURE 3.3

INJECTION VENT WELL (VW1) CONSTRUCTION DETAIL BUILDING 457 AREA

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

Source: Halliburton NUS, 1995

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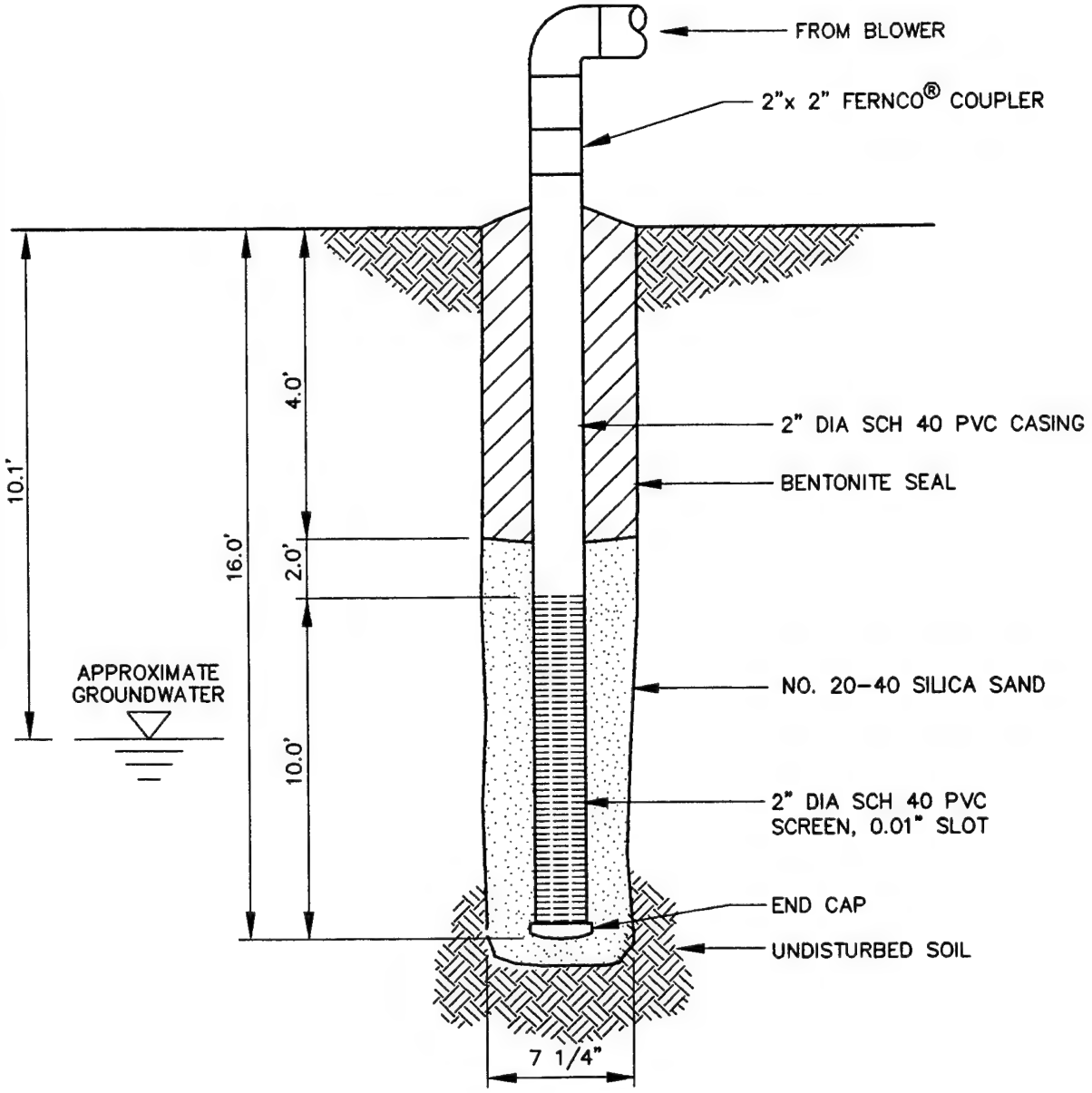
MONITORING WELL TW1501



NOT TO SCALE

FIGURE 3.4

AS-BUILT
INJECTION VENT WELL (VW2)
CONSTRUCTION DETAIL
BUILDING 457 AREA

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

Source: Halliburton NUS, 1995

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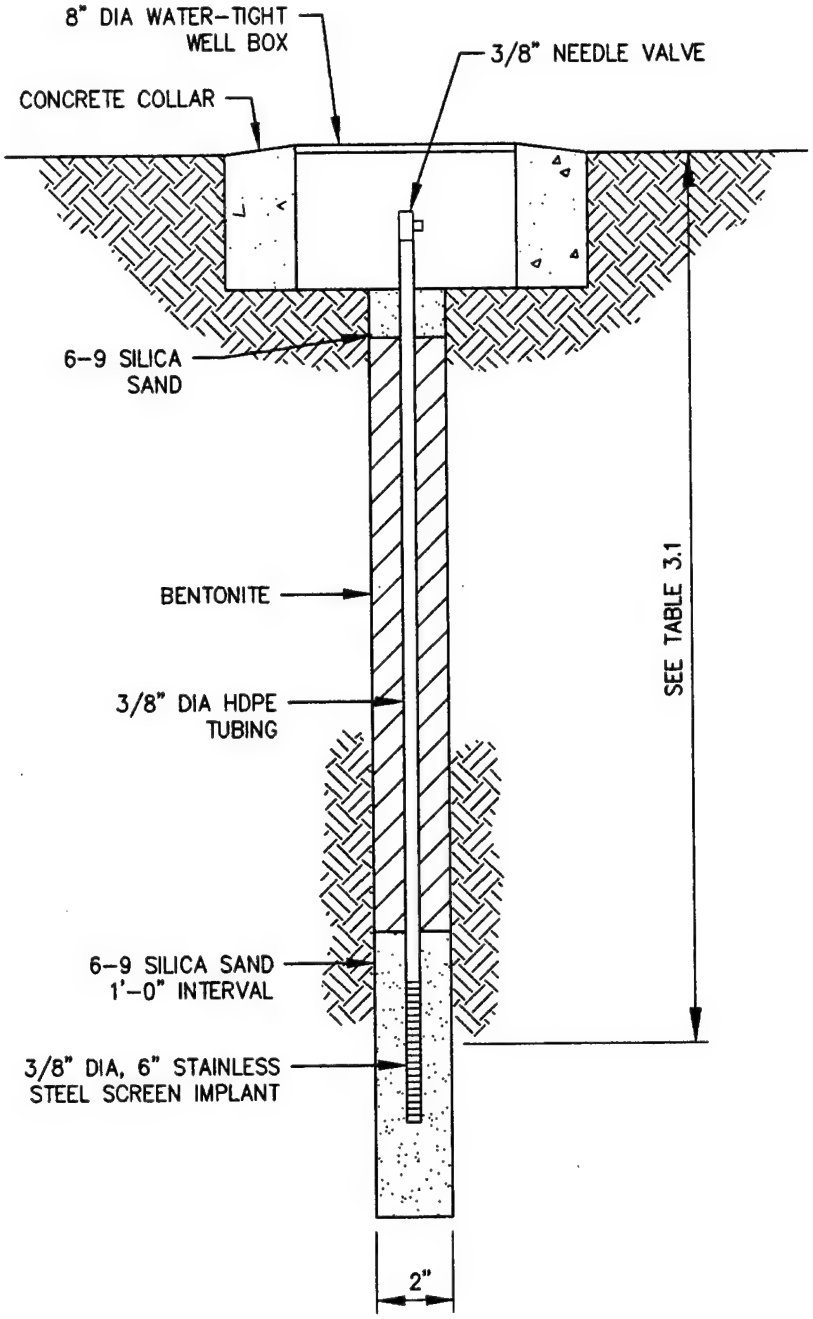


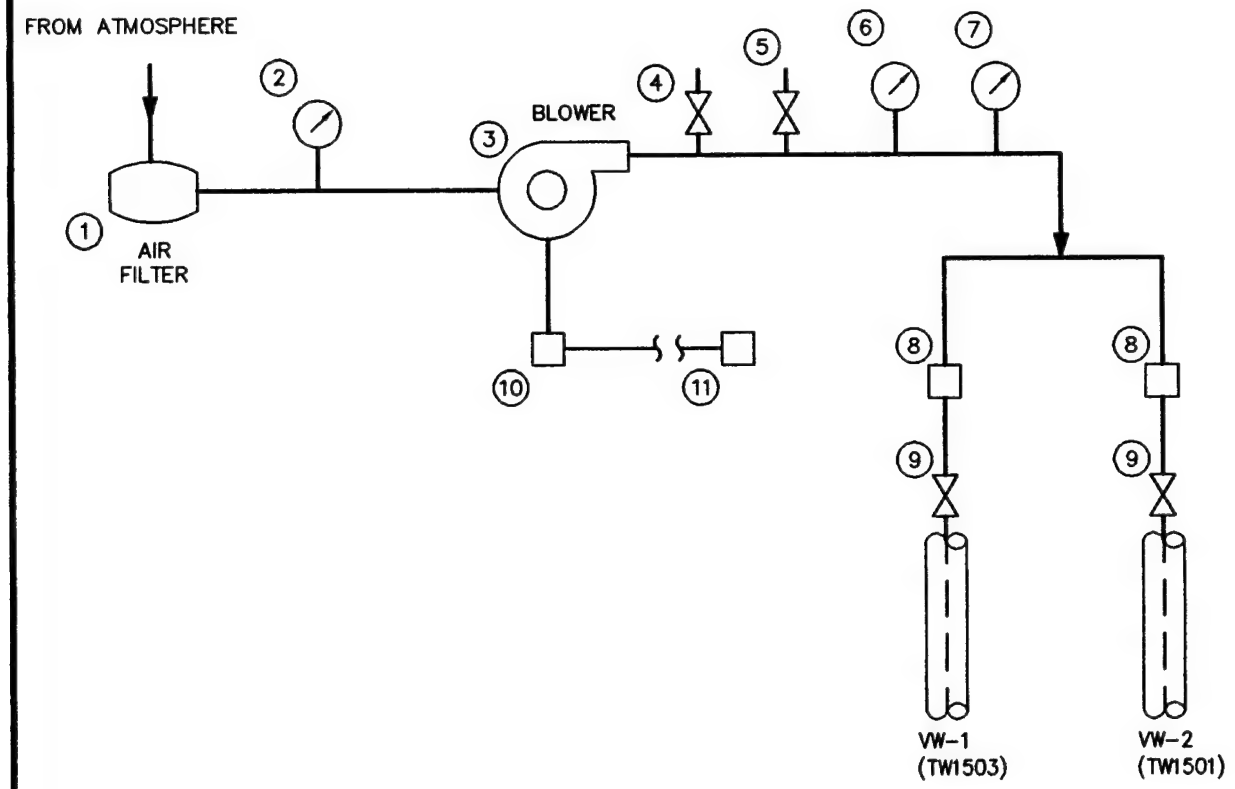
FIGURE 3.5

AS-BUILT MONITORING POINT CONSTRUCTION DETAIL BUILDING 457 AREA (TYPICAL)

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado



LEGEND

1. INLET AIR FILTER – SOLBERG F-30P-150
2. VACUUM GAUGE (IN H_2O)
3. BLOWER – GAST® 1.0HP R4310P-50
4. MANUAL PRESSURE RELIEF (BLEED) VALVE 1 1/2" GATE
5. AUTOMATIC PRESSURE RELIEF VALVE
6. TEMPERATURE GAUGE – (°F)
7. PRESSURE GAUGE – (IN H_2O)
8. FLOW MEASURING PORT FITTED WITH PLUG
9. FLOW CONTROL VALVE – 1 1/2" GATE
10. STARTER
11. BREAKER BOX – 230V/THREE PHASE/15 AMP

NO SCALE

FIGURE 3.6

AS-BUILT BLOWER SYSTEM INSTRUMENTATION DIAGRAM FOR AIR INJECTION BUILDING 457 AREA

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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The 1.0-horsepower blower system has sufficient reserve air-flow capacity to provide air to future, additional VWs if results of additional sampling at the site during the 1-year sampling event indicate that additional VWs are required to remediate the entire volume of contaminated soil at this site (see Section 3.4). The excess air flow is presently being bled off using the manual gate valve (Figure 3.6).

3.2 Pilot Test Soil and Soil Gas Sampling Results

3.2.1 Sampling Results

Unsaturated soils at this site consist generally of approximately 8 to 9 feet of silty clay, and clayey silt with traces of sand (Figure 3.2). Groundwater was measured in VW1 (TW1503) and in VW2 (TW1503) at depths of approximately 9 and 10 feet bgs, respectively, prior to air injection. At MPA perched water was initially observed at a depth of 5 feet bgs. More detailed geological information regarding B457 Area can be found in the geological cross-section (Figure 3.2) and the geologic boring logs (Appendix A).

Petroleum-hydrocarbon-contaminated soils at this site were encountered beginning at a depth of approximately 4.5 feet bgs in each MP borehole and extended to the groundwater surface at depths between 7 and 9 feet bgs. Contaminated soils were identified based on odor, staining, and headspace VOC field screening results. Contaminated soils were encountered in all MP boreholes, with the highest contaminant concentration occurring in the MPB borehole. Soils at these locations had a mild to strong hydrocarbon odor, and a gray-stained soil layer was encountered at depths between approximately 5 and 9 feet bgs in the MP boreholes (Figure 3.2).

Three soil samples for laboratory analysis were collected from Geoprobe® polybutyrate liners. Soil sample headspace was screened for VOCs using a PID to determine the presence of contamination and to select soil samples for laboratory analysis. Soil samples for laboratory analysis were collected from 5 feet bgs from MPA and MPB, and from a depth of 6 feet from MPC. A background soil sample was collected from an apparently uncontaminated area approximately 1,000 feet southeast of the site at a depth of 2.5 feet bgs. Soil samples were shipped via Federal Express® to Evergreen Analytical Laboratory in Wheat Ridge, Colorado for chemical and physical analysis. Soil samples were analyzed for total extractable petroleum hydrocarbons (TEPH) by EPA Method SW8015 (modified); and for BTEX by EPA Method SW8020. Samples were also analyzed for iron, alkalinity, TKN, and several physical parameters. The background soil sample was analyzed only for TKN. Copies of the chain-of-custody forms are included in Appendix A. The results of these analyses are provided in Table 3.2.

Soil gas samples for laboratory analyses were collected prior to performing the *in situ* respiration test in laboratory-provided, evacuated, 1-liter SUMMA® canisters. Soil gas samples were collected by extracting soil gas from VW1; and at depths of 5 feet from MPB and 4.5 feet from MPC. All soil gas samples were collected following procedures in the protocol document (Hinchee *et al.*, 1992). Soil gas samples were shipped via Federal Express® to Air Toxics, Inc. in Folsom, California for TVH and

BTEX analysis using EPA Method TO-3. Copies of the chain-of-custody forms are included in Appendix A. The results of these analyses are provided in Table 3.2.

The maximum concentration of TEPH measured in subsurface soils was 5,000 mg/kg at 5 feet bgs from MPB. For each soil and soil gas sample, BTEX concentrations were very low, with the exception of the soil sample from MPB, which contained 3.4 mg/kg of xylenes.

3.2.2 Exceptions to Test Protocol Document Procedures and Work Plan

Procedures described in the protocol document (Hinchee *et al.*, 1992) were used to complete pilot tests at B457 Area. The only exceptions were that a thermocouple was not installed in a vapor MP and helium was not used during the respiration test. Prior to air injection for the respiration testing, the helium regulator was found to be faulty. Also, an initial soil gas sample for laboratory analysis was not collected from MPA because the screened interval was under perched water. Because the contamination at this site is so shallow and localized, only three soil samples were collected.

Because most of the contaminated soil was removed during tank removal activities, limited areas of contamination remain adjacent to the former tank excavation. Because existing monitoring wells TW1501 and TW1503 are placed in oxygen-deficient soils and are screened above the groundwater table, these wells were used as VWs. Therefore, a VW was not installed as proposed in the work plan. Moreover, because additional work was performed at SS1, the proposed work at the 410 Area (adjacent to B457 Area) was not conducted.

3.3 Pilot Test Results

3.3.1 Initial Soil Gas Chemistry

Prior to initiating any air injection, soil gas in the VWs (TW1503 and TW1501), all MPs, and two of the other existing groundwater monitoring wells (TW1504 and TW1502) was analyzed for initial oxygen, carbon dioxide, and TVH concentrations using portable gas analyzers, as described in the technical protocol document (Hinchee *et al.*, 1992). Table 3.3 summarizes the initial soil gas chemistry. The VWs, MPs, and MWs were purged until oxygen levels had stabilized to remove stagnant gas prior to collecting soil gas samples.

At the VWs and all MP screened intervals, soil gas oxygen concentrations were below the atmospheric concentration of approximately 21 percent. Depleted oxygen concentrations indicate significant biological activity and soil contamination. The most significant oxygen depletion was measured at depths of 4 to 7 feet bgs at MPB and MPC, where the oxygen concentrations were at 0.0 percent. Soil gas BTEX concentrations were 5.5 ppmv and 0.5 ppmv, respectively. Results indicate only slight soil BTEX contamination at the VWs and at each MP. Oxygen concentrations of less than or equal to 5.1 percent were observed at these locations, indicating significant biological activity associated with contaminated soils. Initial oxygen concentrations at monitoring wells TW1502 and TW1504 were measured at 9.5 and 7.9 percent, respectively (Table 3.3). These higher soil gas oxygen concentrations indicate less fuel

TABLE 3.2
SOIL AND SOIL GAS ANALYTICAL RESULTS
BUILDING 457 AREA
EAKER AFB, ARKANSAS

Analyte (Units)[a/]	Sample Location-Depth (feet below ground surface)		
Soil Gas Hydrocarbons	VW1	MPB-5	MPC-4.5
TVH[b/] (ppmv)	48	380	81
Benzene (ppmv)	0.016	0.34	0.13M[c/]
Ethylbenzene (ppmv)	0.048	1.5	0.084
Toluene (ppmv)	0.17	2.7	0.024
Xylenes (ppmv)	0.80	0.93	0.28
Soil Hydrocarbons	MPA-5	MPB-5	MPC-6
TEPH - diesel[d/] (mg/kg)	1,900	5,000	290
Benzene (µg/kg)	< 2.4	< 230	< 0.4
Toluene (µg/kg)	< 2.4	< 230	< 0.4
Ethylbenzene (µg/kg)	< 2.4	< 230	< 0.4
Xylenes (µg/kg)	6.8	3,400	< 0.4
Soil Inorganics	MPB-5	MPB-6	BG-2.5
pH (pH units)	6.8	7.1	---[e/]
Iron (mg/kg)	14,100	17,000	---
Alkalinity (mg/kg)	< 30.3	< 30.5	---
TKN (mg/kg)	150	150	< 4.6
Phosphorus (mg/kg)	< 2.4	< 2.6	---
Soil Physical Parameters	MPB-5	MPB-6	
Moisture (% wt.)	17.4	17.9	
Gravel (%)	0.0	0.0	
Sand (%)	46.5	52.0	
Fines (Silt and Clay) (%)	53.5	48.0	

a/ ppmv=parts per million, volume per volume; mg/kg=milligrams per kilogram; µg/kg=micrograms per kilogram; TKN=total Kjeldahl nitrogen; TVH=total volatile hydrocarbons; TEPH=total extractable petroleum hydrocarbons; wt.=weight.

b/ TVH referenced as jet fuel (molecular weight=156) and analyzed by USEPA Method TO-3.

c/ M = Reported value may be biased due to apparent matrix interferences.

d/ TEPH analyzed for by USEPA Method SW8015 modified for diesel fuel.

e/ --- = Not analyzed.

TABLE 3.3
INITIAL SOIL GAS CHEMISTRY
BUILDING 457 AREA
EAKER AFB, ARKANSAS

Sample Location	Screen Depth (feet)	O_2 (%)	CO_2 (%)	Field TVH (ppmv) [a/]	Laboratory TVH (ppmv) [b/]
VW1 (TW1503)	5.5-15.5	5.0	8.0	540	48
VW2 (TW1501)	6-16	2.5	10.3	540	---[c/]
MPA[d/]	5.5	5.1	1.6	230	---
MPB	5	0.0	8.0	3,200	380
MPC	4.5	0.0	8.1	920	81
TW1502[e/]	8-18	9.5	7.3	94	---
TW1504[e/]	5.5-15.5	7.9	5.9	140	---

a/ Total volatile hydrocarbon field screening results reported in parts per million, volume per volume.

b/ Laboratory total volatile hydrocarbon analytical results referenced to jet fuel (molecular weight=156).

c/ --- = Not analyzed.

d/ Sample could not be collected prior to air injection for the respiration test because the screened interval was under perched groundwater. Therefore, soil gas chemistry after initial air injection and prior to air injection for the permeability test is presented. The initial oxygen concentration may have been slightly lower than the value shown; however, based on respiration data and sufficient time for soil gas stabilization, the reported oxygen concentrations may closely represent initial soil gas concentrations.

e/ Sample collected during the initial site visit on November 16, 1995.

contamination (and less resulting biological activity) at the monitoring wells. The relatively elevated oxygen concentrations at these monitoring wells may be the result of oxygen being supplied by natural diffusion from the atmosphere and the nearby backfill. Smear zone contamination may be affecting oxygen concentrations in these wells.

TVH field measurements at the VW and MPs ranged from 540 to 3,200 ppmv, and laboratory TVH results ranged from 48 to 380 ppmv. The highest TVH concentrations were measured at depths below 4 feet, indicating an interval of significant fuel contamination.

3.3.2 Air Permeability

An air permeability test was conducted according to protocol document procedures. Air was injected into VW1 for 2 hours at a rate of approximately 11.5 scfm and an average pressure of 26 inches of water. The maximum pressure response at each MP is listed in Table 3.4. The pressure measured at the MPs increased rapidly during the first 5 minutes of the test, then at a much slower rate for the remainder of the test. Due to the rapid pressure response, the steady-state method of determining air permeability was selected. A soil gas permeability value of approximately 8 darcys, typical for silty, sandy clay soil, was calculated for this site. A radius of pressure influence of at least 25 feet was observed at depths greater than 4 feet. At MPC-4.5, the farthest measuring point from VW1 at a distance of 24.5 feet, the maximum pressure response was 0.05 inch of water. At MPA-5.5, 5.5 feet from VW1, the maximum pressure response was 1.4 inches of water.

3.3.3 Oxygen Influence

The radius of oxygen increase in the subsurface resulting from air injection into the VW during pilot testing is the primary design parameter for full-scale bioventing system design. Optimization of full-scale and multiple VW systems require pilot testing to determine the volume of soil that can be oxygenated at a given flow rate and VW screen configuration.

Table 3.5 presents the changes in soil gas oxygen levels that occurred during a 47-day injection period using the extended pilot test blower unit. This period of air injection at approximately 13.0 scfm per VW produced increases in soil gas oxygen levels at each MP screened interval. A decrease in soil gas oxygen was observed at well TW1502, indicating that the soil gas was migrating outward from the area of higher contamination into the area of lesser contamination. Based on measured changes in oxygen levels, it is anticipated that the radius of influence for a long-term bioventing system at this site will exceed 25 feet at all depths. Monitoring during the extended pilot test at this site will better define the effective treatment radius.

3.3.4 *In Situ* Respiration Rates

The *in situ* respiration test was performed by injecting air (oxygen) into VW1 and each MP screened interval (MPA-5.5, MPB-5, and MPC-4.5) for a 37-hour period. Oxygen loss and other changes in soil gas composition over time were then measured at

TABLE 3.4
MAXIMUM PRESSURE RESPONSE
AIR PERMEABILITY TEST
BUILDING 457 AREA
EAKER AFB, ARKANSAS

Location	Distance From VW1 (feet)	Screen Depth (feet bgs)[a/]	Elapsed Time to Maximum Pressure (minutes)	Maximum Pressure Response (inches of water)
MPA	5.5	5.5	120	1.40
MPB	13.7	5	120	0.32
MPC	24.5	4.5	120	0.05

[a/] bgs = below ground surface.

TABLE 3.5
INFLUENCE OF AIR INJECTION AT VWs ON
MONITORING POINT OXYGEN CONCENTRATIONS
BUILDING 457 AREA
EAKER AFB, ARKANSAS

Location	Distance From VW1 (feet)	Screen Depth (feet bgs) [a/]	Initial O_2 [b/] (%)	Final O_2 [c/] (%)
MPA	5.5	5.5	5.1	20.4
MPB	13.7	5	2.2	8.2
MPC	24.5	4.5	2.2	6.6
TW1502	60.0	8-18	9.5 [d/]	4.7

[a/] bgs = below ground surface.
[b/] Measurement taken prior to the respiration test and air injection at VWs.
[c/] Measurement taken following approximately 47 days of air injection at VWs.
[d/] Sample collected during the initial site visit on November 16, 1995.

these intervals. Oxygen, TVH, and carbon dioxide, were measured for a period of approximately 11 hours following air injection. The measured oxygen losses were then used to calculate biological oxygen utilization rates. The results of *in situ* respiration testing for VWs, MPA-5.5, MPB-5, and MPC-4.5 are presented in Figures 3.7 through 3.10, respectively. Table 3.6 provides a summary of the oxygen utilization and fuel degradation rates.

Oxygen losses measured at VW1 and each MP occurred at very high rates, ranging from 2.6 percent per hour at VW1 to 3.5 percent per hour at MPC-4.5. At MPC-4.5, the oxygen dropped from 20.6 percent to 0.0 percent in 10.5 hours. Based on the helium retention results obtained during the respiration testing at SS1 (Section 2.3.4), it is expected that the measured oxygen loss at B457 Area is the result of bacterial respiration and not due to diffusion away from the MPs.

Based on these oxygen utilization rates, an estimated 1,220 to 1,620 mg of fuel per kg of soil can be degraded each year at this site. This conservative estimate is based on an average air-filled porosity of approximately 0.01 liter per kg of soil, and a ratio of 3.5 mg of oxygen consumed for every 1 mg of fuel biodegraded. Actual degradation rates may be lower since the contaminant is a heavy hydrocarbon.

3.3.5 Potential Air Emissions

Soil gas concentrations of TVH compounds detected were less than 400 ppmv; however, the majority of contamination at B457 Area is shallow (between 4.5 and 7 feet bgs). Also, the VWs are located within 15 feet of the former tank excavation, which may provide a preferential air flow pathway. Consequently, the long-term potential for air emissions from full-scale bioventing operations at this site is considered moderate. VOC emissions should be minimal, however, because of the type and age of the site contaminants (greater than 5 years, and primarily fuel oil), and the low air injection rates (14.7 scfm per well), and because accumulated vapors will move slowly outward from the air injection points and will be biodegraded as they move horizontally through the soil. To confirm this, a GasTech® total hydrocarbon vapor analyzer will be used to monitor the breathing zone during the April 1997 field event. During pilot testing at B457 Area, health and safety monitoring of ambient air was not conducted because of windy conditions that would have provided biased results. Finally, the site is very isolated on Eaker AFB, and is located several thousand feet from any permanently occupied building.

3.4 Recommendations

Initial bioventing tests at this site indicate that oxygen has been depleted in the contaminated soils, and that air injection is an effective method of increasing aerobic fuel biodegradation. It is recommended that air injection continue at this site to determine the long-term radius of oxygen influence and the effects of time and available nutrients on fuel biodegradation rates.

A small, 1-horsepower regenerative blower has been installed at the site to continue air injection into VW1 and VW2 at a rate of approximately 14.7 scfm. The 1-year test period funded under Option 1 of the Extended Bioventing Project began on April 5,

FIGURE 3.7
INITIAL RESPIRATION TEST RESULTS AT VW1
BUILDING 457 AREA
EAKER AFB, ARKANSAS

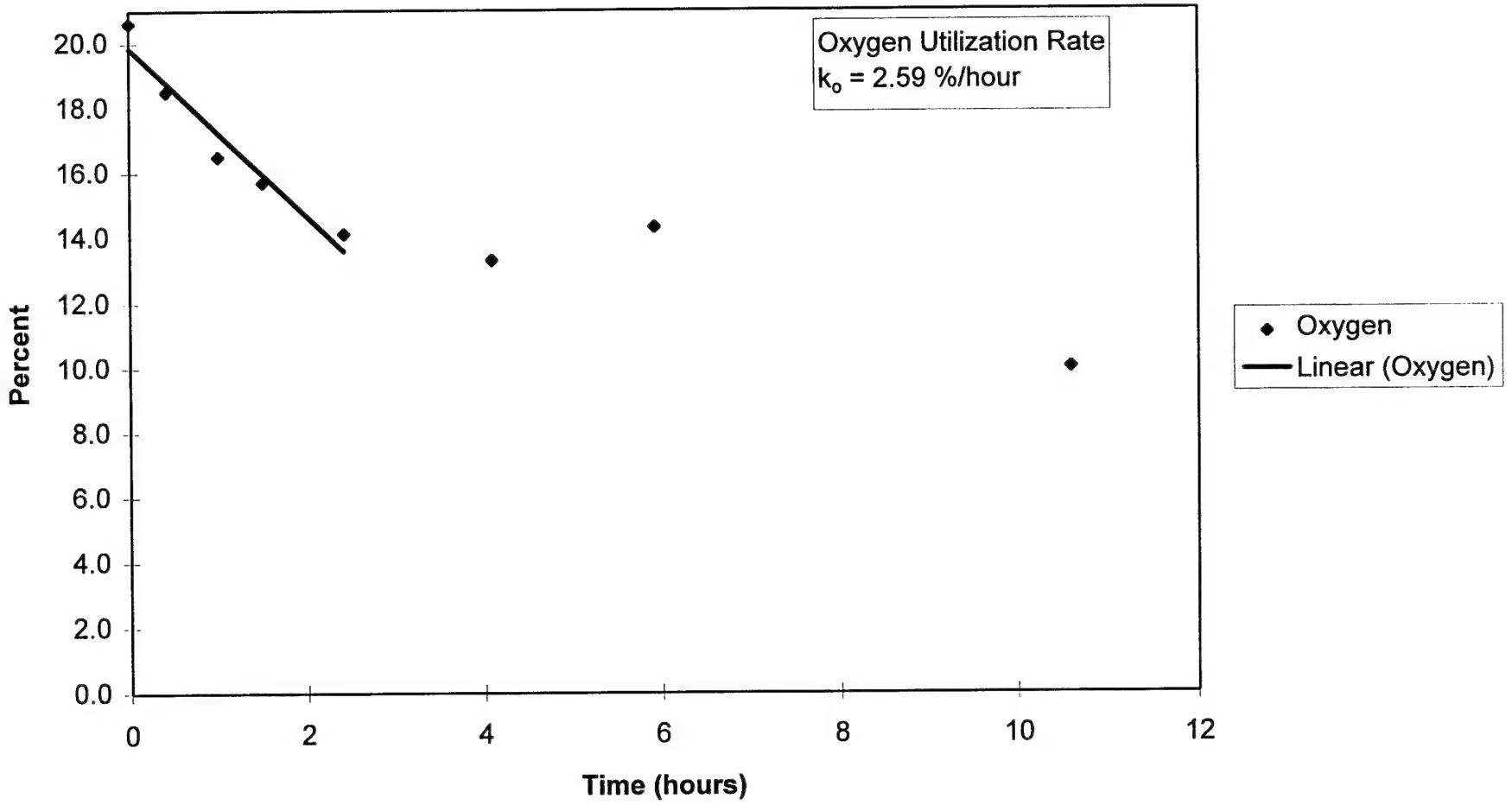

FIGURE 3.8
INITIAL RESPIRATION TEST RESULTS AT MPA-5.5
BUILDING 457 AREA
EAKER AFB, ARKANSAS

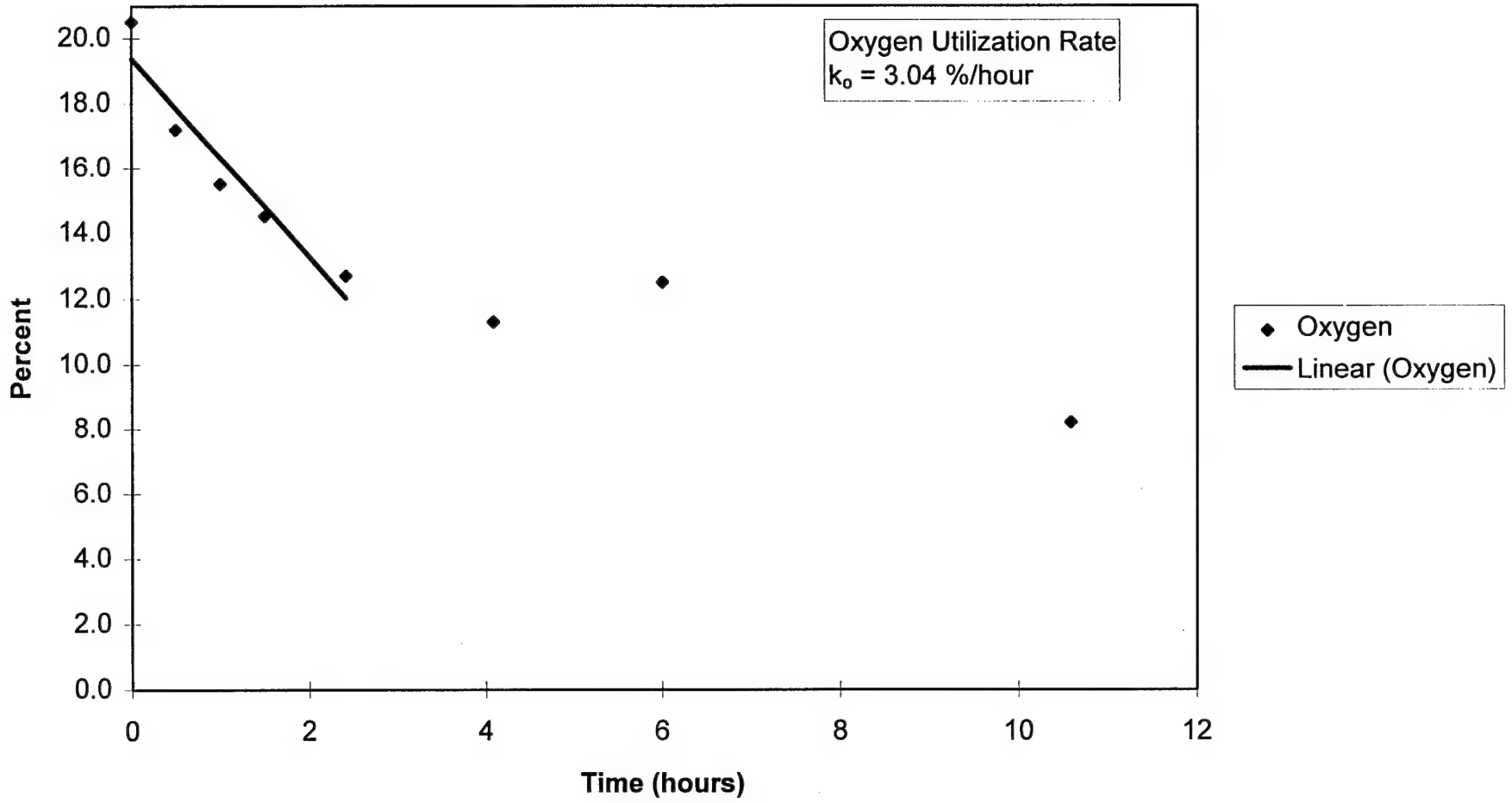

FIGURE 3.9
INITIAL RESPIRATION TEST RESULTS AT MPB-5
BUILDING 457 AREA
EAKER AFB, ARKANSAS

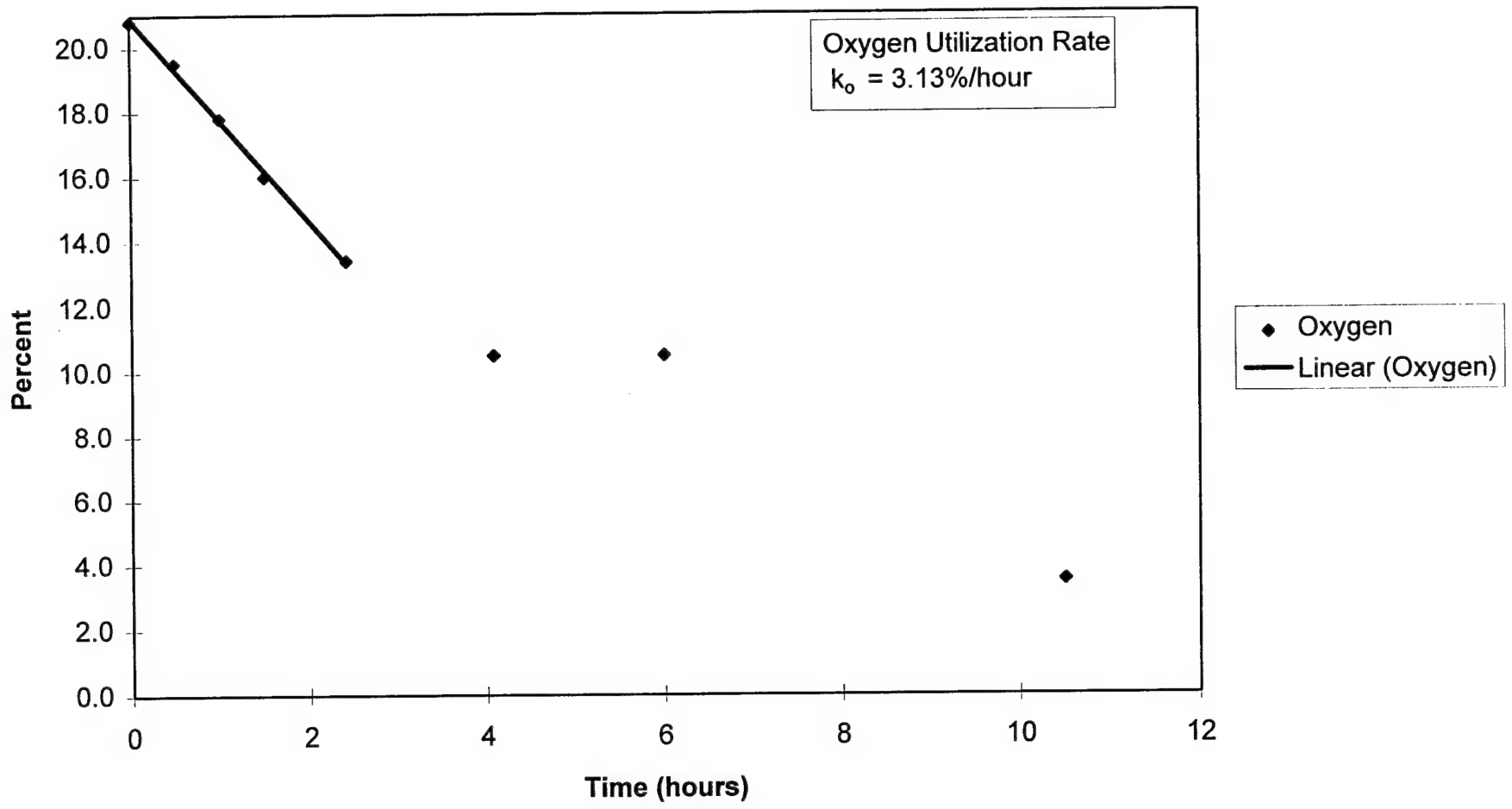

FIGURE 3.10
INITIAL RESPIRATION TEST RESULTS AT MPC-4.5
BUILDING 457 AREA
EAKER AFB, ARKANSAS

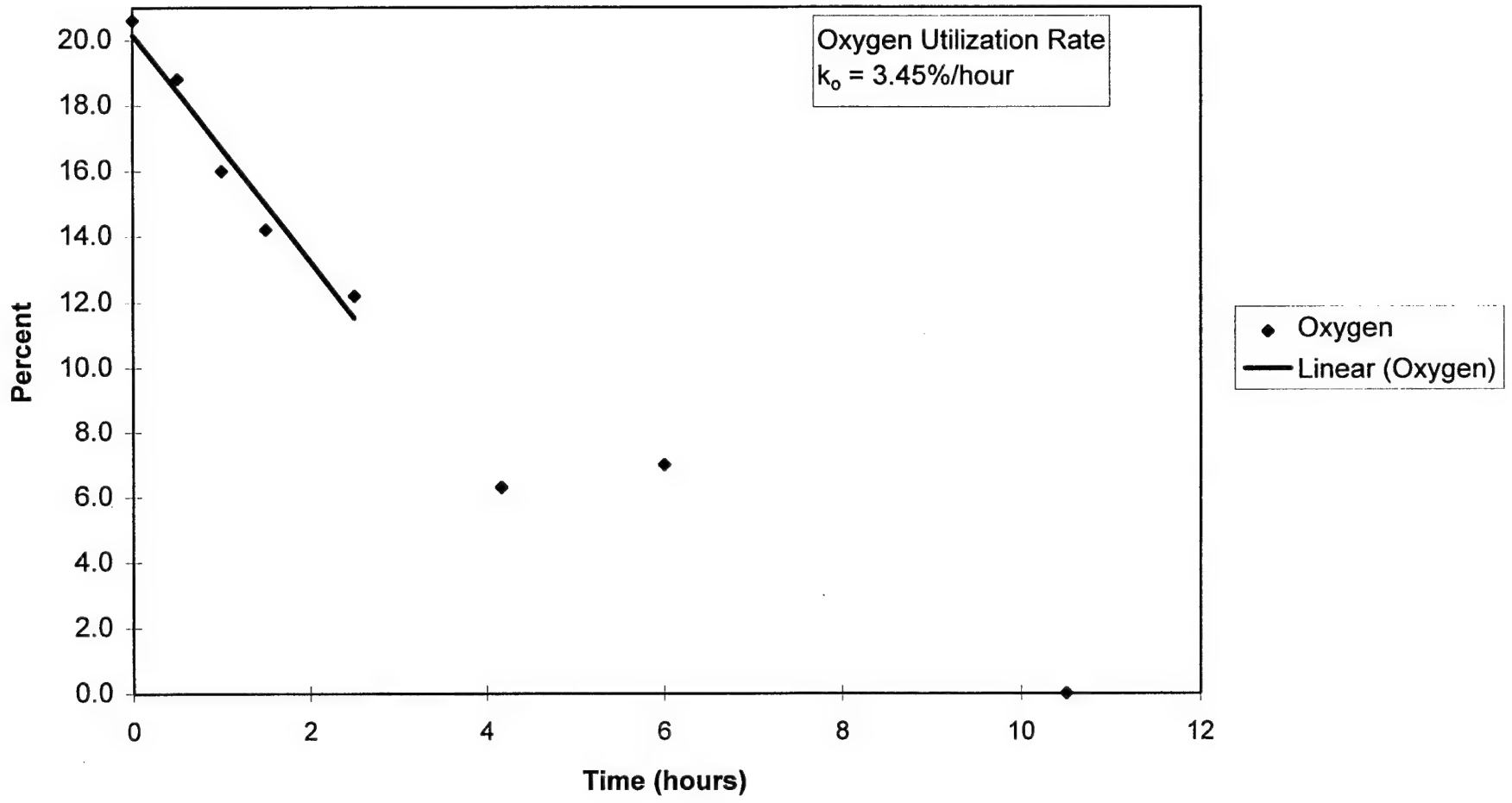

TABLE 3.6
OXYGEN UTILIZATION AND FUEL DEGRADATION RATES
BUILDING 457 AREA
EAKER AFB, ARKANSAS

Location-Depth (feet bgs) [a/]	Test Duration (hours)	0_2 Loss (%)	O_2 Utilization Rate [b/] (%/hour)	Fuel Degradation Rate (mg TPH/kg/year)[c/]
VW1 5.5-15.5	2.4	6.5	2.59	1,220
MPA-5.5	2.4	7.8	3.04	1,430
MPB-5	2.4	7.4	3.13	1,470
MPC-4.5	2.4	8.4	3.45	1,620

[a/] bgs = below ground surface.
[b/] Values based on best-fit lines (Figures 3.7 through 3.10).
[c/] mg TPH/kg/year = milligrams of total petroleum hydrocarbons per kilogram of soil per year.

1996. Parsons ES will operate the blower through April 7, 1997, conduct radius of oxygen influence measurements on April 7, 1997, shut off the blower, and then conduct follow-up "area" respiration tests. Approximately 1 month later (May 1997), Parsons ES will mobilize the Geoprobe® rig to the site to perform additional soil sampling and MP installation (if necessary). Figure 3.11 shows the proposed additional Geoprobe® boring and possible MP locations at B457 Area. In addition, during the May 1997 field event, Parsons ES will collect soil gas samples from the three MPs that were sampled during the initial sampling event (Table 3.2) to determine the levels of cleanup achieved after 1 year of *in situ* treatment.

The current bioventing pilot-scale system appears to be treating most of the vadose zone contamination at B457 Area; however, one or two more VWs may be required to treat the entire volume of contaminated soil. Considering that limited soil analytical data are available, areas outside the current area of venting influence may have some residual vadose zone and smear zone contamination. During the May 1997 field event, Parsons ES will install approximately seven more Geoprobe® borings to further define the FAE of contamination and to determine whether or not additional VWs will be necessary (Figure 3.11). Borings that exhibit soil contamination will be converted into vapor MPs. Additional MPs will be installed and constructed in the same manner as MPA, MPB, and MPC, except a thermocouple will be installed in one MP. Two borings will be placed near the eastern edge of the former tank excavation to determine whether of not an additional VW will be required in that area. If contamination is observed at the boring near monitoring well TW1504, it will be recommended that the well be converted to a VW. A soil sample collected adjacent to MPB at a depth of 5 feet bgs will be used to document contaminant reduction in soils. All soil sampling activities will be conducted under the assumption that sampling results will eventually be used to obtain site closure. Approximately six soil samples will be analyzed for TEPH by EPA Method SW8015M.

Results of the initial air permeability test indicate that the radius of oxygen influence exceeds 25 feet. Oxygen influence measurements taken at the end of 1 year of system operation will be used to determine the actual radius of influence and to assess the need for additional VWs. Soil gas measurements taken at the end of 1 year of system operation will be used to confirm contaminant reduction.

Based on the oxygen influence observed following 46 days of air injection during the "wet" season, it is anticipated that the shallow groundwater at B457 Area will not significantly limit the radius of oxygen influence. However, it should be noted that the bioventing technology will not treat the contaminated soils below the groundwater table. Soil sampling conducted during tank removal activities indicated that petroleum-contaminated soils were present at depths to 12 feet bgs (Ogden, 1995). Considering that the groundwater table fluctuates at depths of 9 to 11 feet bgs, some of the contaminated soil will remain untreated. Therefore, an eventual risk-based approach to site closure is recommended for B457 Area. Except for xylenes, none of the BTEX constituents were detected in soil, and groundwater analytical results from downgradient monitoring wells suggest that dissolved petroleum hydrocarbon contaminants have not migrated more than 20 feet beyond the edge of the former tank excavation (US Air Force, 1995). The potential for off-Base migration of contaminated groundwater from the B457 Area is considered to be very low.

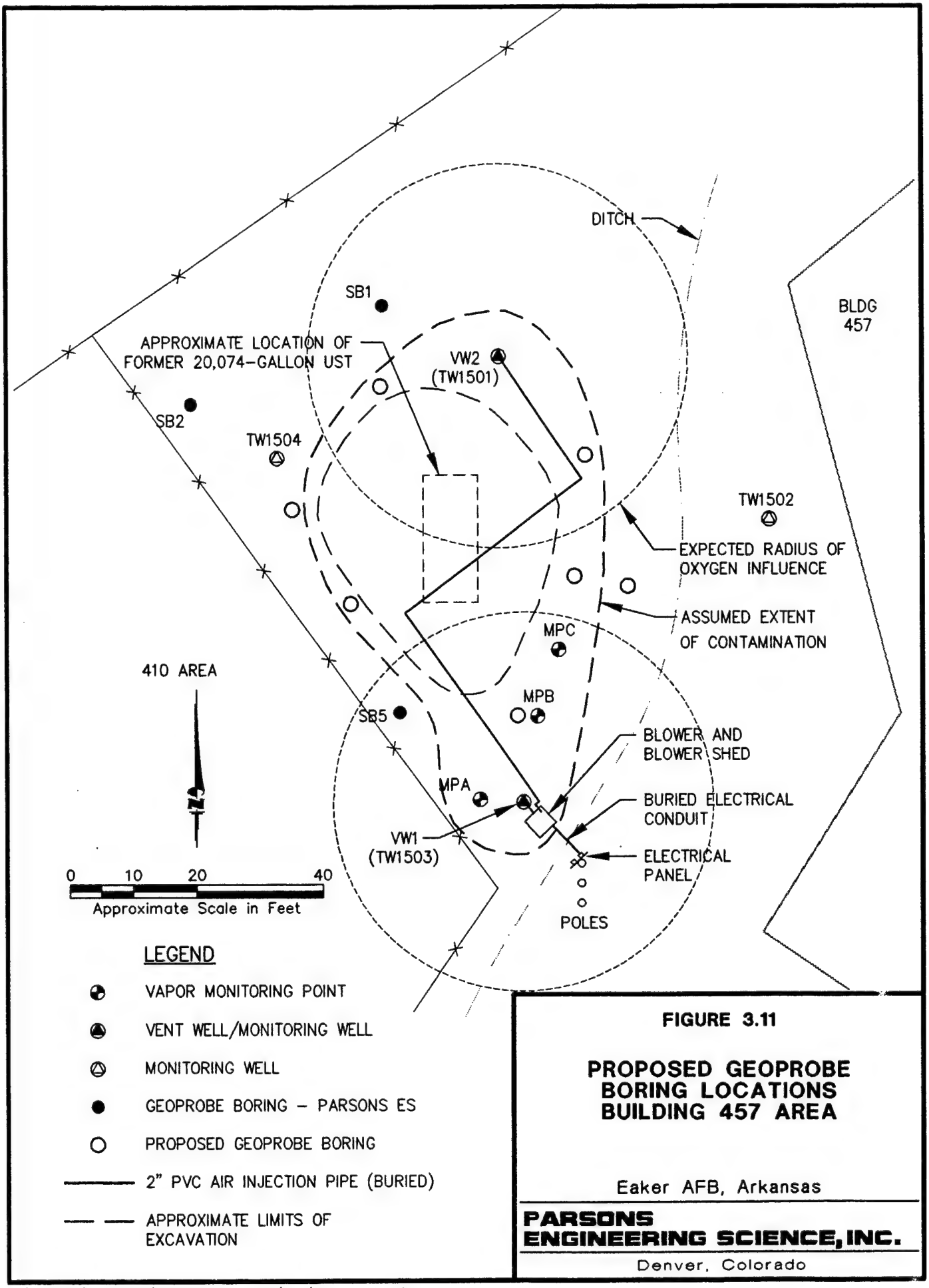

FIGURE 3.11

PROPOSED GEOPROBE BORING LOCATIONS BUILDING 457 AREA

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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Therefore, the potential for downgradient receptors to be exposed to contaminated groundwater is low, because contaminant migration appears to be minimal. It is likely that intrinsic bioremediation processes coupled with active remediation (bioventing) will continue to reduce hydrocarbon concentrations in soil and groundwater at the site. As the vadose zone is bioremediated via bioventing, contaminant loading (leaching and dissolution) into the groundwater will be reduced significantly, thereby further reducing any potential threat to human health and the environment.

4.0 PILOT TEST RESULTS - UST 702

The source of soil contamination at this site was the former 2,010-gallon UST 702, which was used to store fuel oil. The tank, along with a majority of the grossly contaminated soils, has been removed (Ogden, 1995)

4.1 Pilot Test Design and Construction

An initial bioventing pilot test was performed by Parsons ES at UST 702 during the period from March 18 through April 5, 1996. A total of 12 Geoprobe® boreholes were drilled at the site to better define the extent of the vadose zone contamination, and to determine appropriate vapor MP screen depths and locations and optimal VW placement. Because the petroleum contamination at UST 702 is highly localized, existing monitoring well TW1601 is being used as the VW for air injection. Installation of three single-depth vapor MPs took place on March 21, 1996. The MPs were installed in Geoprobe® boreholes. Electrical services were provided by Cache Valley Electric of Blytheville, Arkansas.

Three MPs, a blower unit, and air injection piping to one monitoring well were installed at the UST 702 site. Figure 4.1 is a site layout showing the locations of the VW, MPs, blower unit, and existing groundwater monitoring wells at the site. The hydrogeology of the site is depicted on the cross-section on Figure 4.2. Boring logs for the Geoprobe® boreholes, MPs and VW are included in Appendix A. The background MP for this site was the existing groundwater monitoring well MW10 described earlier (also see Section 4.1.2), which is screened several feet above the groundwater surface. The following sections describe the final design and installation of the bioventing system at UST 702.

4.1.1 Air Injection Vent Well

Existing temporary groundwater monitoring well TW1601 is being used as the VW at UST 702. The well was installed in oxygen-deficient soils in the center of the tank excavation. The VW is constructed of 2-inch-diameter, schedule 40 PVC casing and slotted PVC screen. Table 4.1 summarizes the VW construction details. Details of the VW construction are presented on Figure 4.3.

4.1.2 Monitoring Points

The single-depth MP screens were installed at the depths listed on Table 4.1. The three MPs (MPA, MPB, and MPC) at this site were constructed as shown in Figure 4.4. Each MP, installed in a Geoprobe® boring, was constructed with a 6-inch-long,

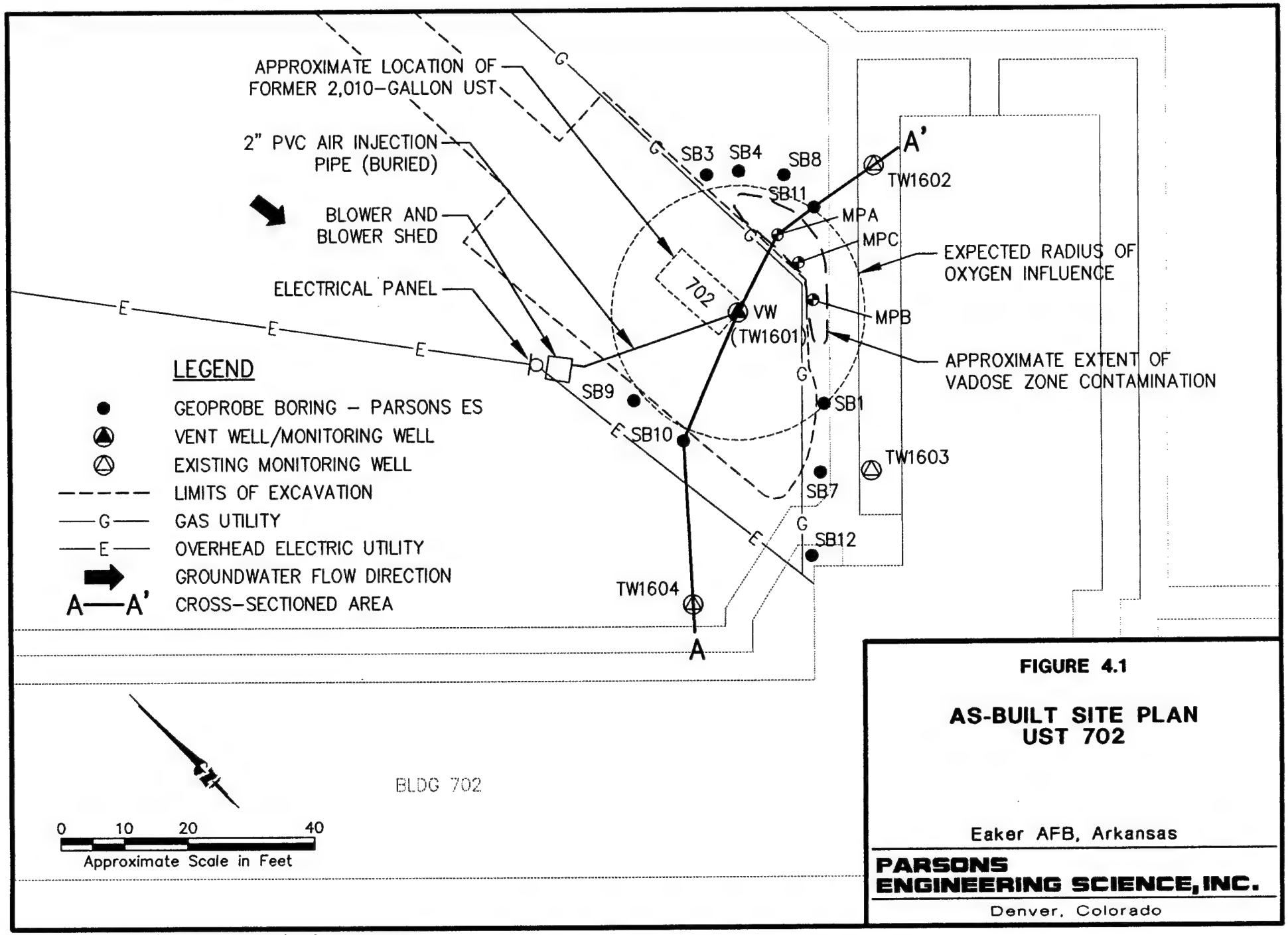

FIGURE 4.1

AS-BUILT SITE PLAN
UST 702

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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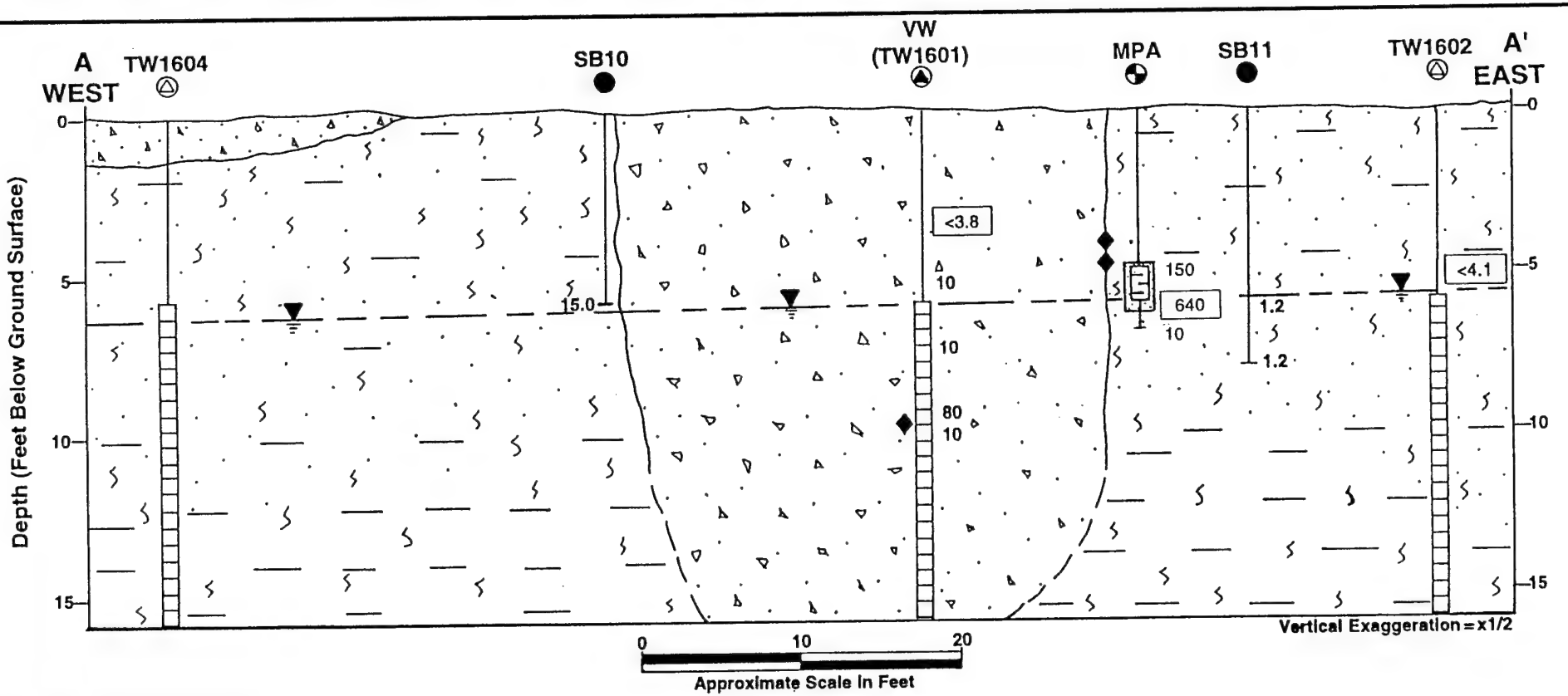


LITHOLOGIC DESCRIPTION

CLAY | SILT | SAND | BACKFILL

LEGEND

TW1601 — VENT WELL/MONITORING WELL	GROUNDWATER ELEVATION, DASHED WHERE INFERRED
TW1604 — MONITORING WELL	GEOLOGIC CONTACT, DASHED WHERE INFERRED
MPA — VAPOR MONITORING POINT	MONITORING POINT SCREENED INTERVAL AND SAND PACK INTERVAL
SB10 — SOIL BOREHOLE	SCREENED INTERVAL
15.0 — FIELD SCREENING RESULTS FOR TOTAL VOLATILE HYDROCARBONS (ppmv)	FUEL ODOR DETECTED DURING DRILLING
640 — LABORATORY RESULTS FOR SOIL TOTAL EXTRACTABLE PETROLEUM HYDROCARBONS (mg/kg)	

FIGURE 4.2

HYDROGEOLOGIC CROSS-SECTION UST 702

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

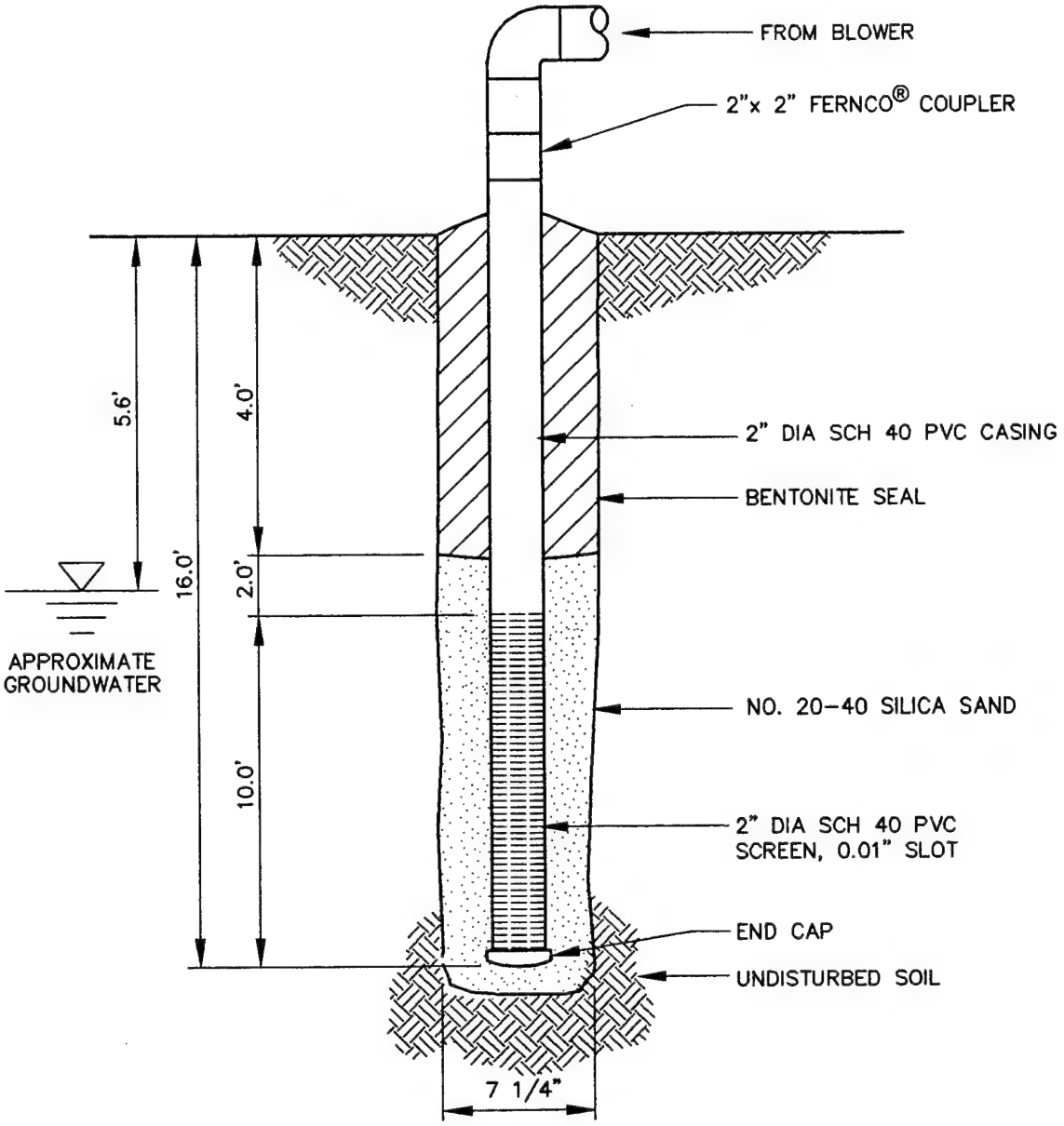
TABLE 4.1
VENT WELL AND MONITORING POINT CONSTRUCTION SUMMARY
BUILDING 702
EAKER AFB, ARKANSAS

Location	Total Borehole Depth (feet bgs) [a/]	Screened Interval (feet bgs)
VW1 (TW1601)	16	6-16
MPA	7	5.5
MPB	6	5
MPC	6	4.5

[a/] bgs = below ground surface.

Note: The monitoring points were completed on March 21, 1996.

MONITORING WELL TW1601



NOT TO SCALE

FIGURE 4.3

AS-BUILT INJECTION VENT WELL CONSTRUCTION DETAIL UST 702

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

Source: Halliburton NUS, 1995

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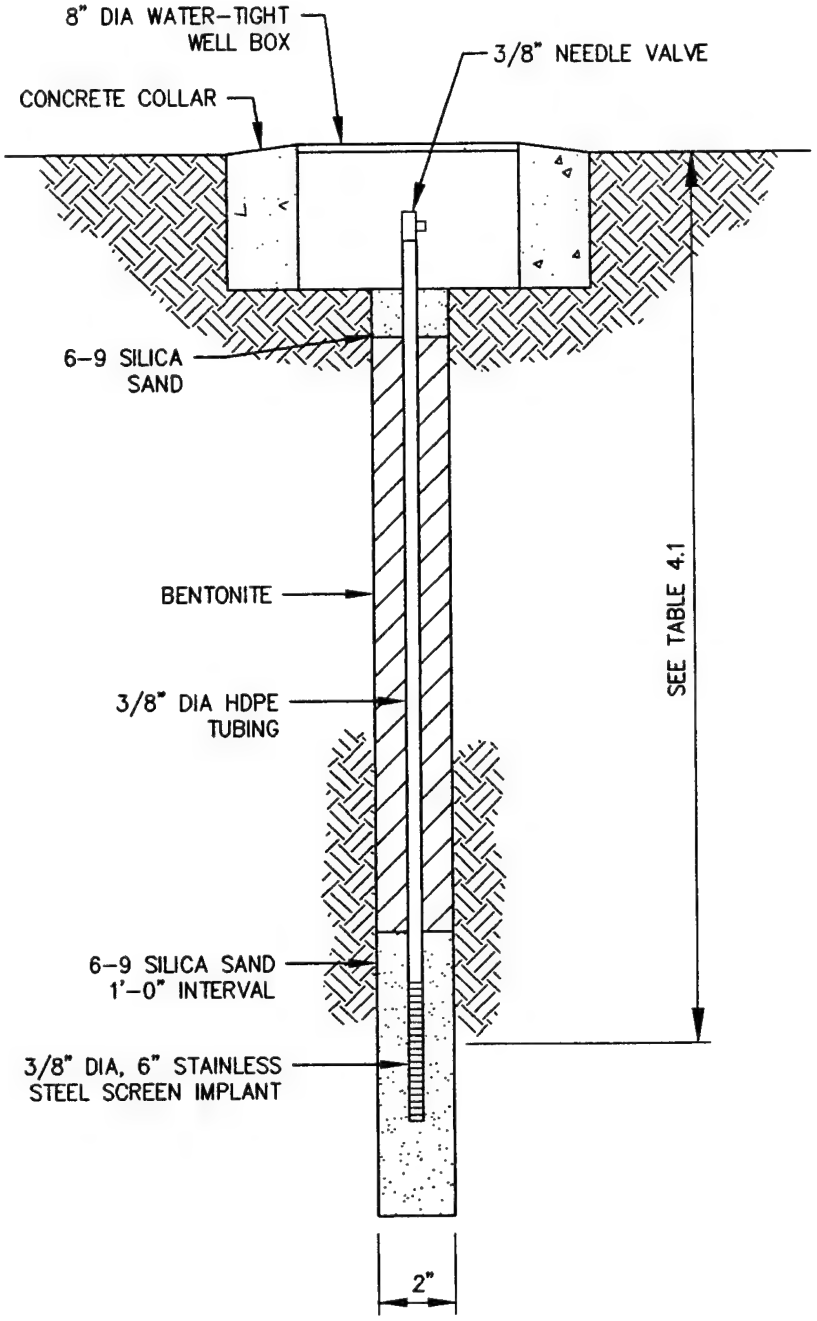


FIGURE 4.4

AS-BUILT MONITORING POINT CONSTRUCTION DETAIL UST 702 (TYPICAL)

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

0.25-inch, OD stainless steel screen implant attached to 0.5-inch-OD, HDPE tubing that extends to the ground surface. The top of each 0.5-inch HDPE riser was completed with a 3/8-inch needle valve. The top of each MP was completed with a flush-mounted metal well protector set in concrete.

The existing groundwater monitoring well MW10, was used as the background MP for this pilot test. MW10 is located in an uncontaminated area approximately 4,500 feet southeast of UST 702 and has a screened interval extending above the groundwater surface.

4.1.3 Blower Unit

A 1-horsepower Gast® regenerative blower unit was used for the initial pilot test and was installed for extended testing. The blower is energized by 230-volt, three-phase, 30-amp line power from a new distribution panel located on a new electrical panel installed on the power pole adjacent to the blower shed (Figure 4.1). The pilot test blower injected air into the subsurface at 15.8 scfm for the initial test at the VW. Once the groundwater surface drops, the injection flow rate for the VW will be re-optimized for the extended pilot test. It is anticipated that the system re-optimization will be completed in August 1996. The final blower wiring was completed, and the system was started on April 5, 1996. The configuration, instrumentation, and specifications for the initial pilot test and extended pilot test units are shown on Figure 4.5. Following the field mobilization, Parsons ES engineers provided an O&M briefing checklist and blower maintenance manual to AFBCA personnel. A copy of the checklist is provided in Appendix C.

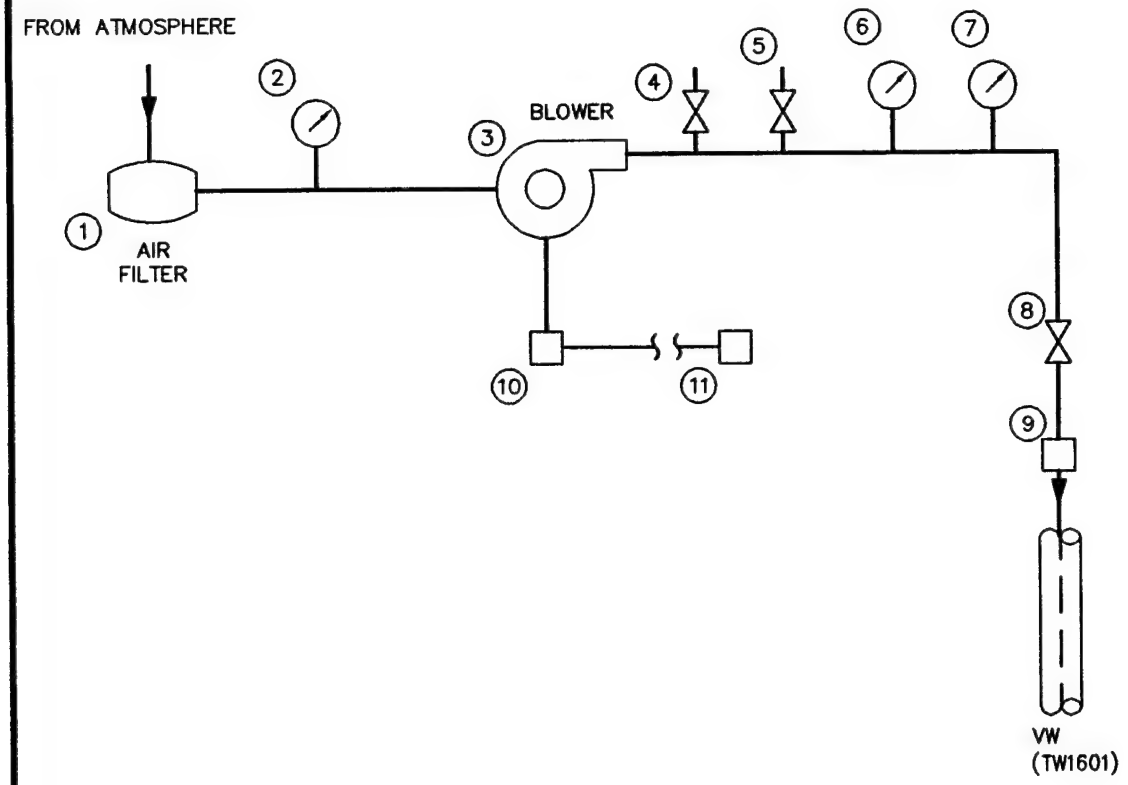
With one VW manifolded to the blower system, the majority of the identified vadose zone soil contamination should be within the anticipated treatment area. However, the 1.0-horsepower blower system has sufficient reserve air-flow capacity to provide air to more than one VW should Eaker AFBCA decide to use the blower at another site in the future. Currently, excess air flow is being bled off using the manual gate valve (Figure 4.5).

4.2 Pilot Test Soil and Soil Gas Sampling Results

4.2.1 Sampling Results

Soils at this site consist generally of approximately 9 to 10 feet of sandy silt overlying clay (Figure 4.2). Groundwater was measured in the VW at a depth of approximately 5.6 feet bgs prior to air injection. More detailed geological information regarding UST 702 can be found in the geological cross-section (Figure 4.2) and the geologic boring logs (Appendix A).

Significantly petroleum-hydrocarbon-contaminated soils at this site were encountered only at one discrete interval in MPB. A black "tar-like" soil sample collected from a depth of 5.5 feet bgs from MPB contained 4,200 mg/kg of TEPH. Much lower levels of TEPH were detected at MPA and MPC, and total BTEX concentrations were very low at all three locations. Contaminated soils were identified based on odor, staining, and headspace VOC field screening results.



LEGEND

1. INLET AIR FILTER – SOLBERG F–30P–150
2. VACUUM GAUGE (IN H_2O)
3. BLOWER – GAST®1.0HP R4310P–50
4. MANUAL PRESSURE RELIEF (BLEED) VALVE 1 1/2" GATE
5. AUTOMATIC PRESSURE RELIEF VALVE
6. TEMPERATURE GAUGE – (°F)
7. PRESSURE GAUGE – (IN H_2O)
8. FLOW CONTROL VALVE – 1 1/2" GATE
9. FLOW MEASURING PORT FITTED WITH PLUG
10. STARTER
11. BREAKER BOX – 230V/THREE PHASE/40 AMP

NO SCALE

FIGURE 4.5
AS-BUILT BLOWER SYSTEM INSTRUMENTATION DIAGRAM FOR AIR INJECTION UST 702

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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Soil samples for laboratory analysis were collected from Geoprobe® polybutyrate liners. Soil sample headspace was screened for VOCs using a PID to determine the presence of contamination and to select soil samples for laboratory analysis. Soil samples for laboratory analysis were collected at 5.5 feet bgs from MPB and MPC boreholes, and at 6.5 feet bgs from MPA. A background soil sample was collected from an apparently uncontaminated area near MW10. Soil samples were shipped via Federal Express® to Evergreen Analytical Laboratory in Wheat Ridge, Colorado for chemical and physical analysis. Soil samples were analyzed for TEPH by EPA Method SW8015 (modified) and for BTEX by EPA Method SW8020. Three samples were also analyzed for iron, alkalinity, TKN, and several physical parameters. The background soil sample was analyzed only for TKN. Copies of the chain-of-custody forms are included in Appendix A. The results of these analyses are provided in Table 4.2.

One soil gas sample for laboratory analysis was collected prior to performing the *in situ* respiration test in a laboratory-provided, evacuated, 1-liter SUMMA® canister. The sample was collected by extracting soil gas from MPB-5. MPB is the only location where oxygen levels were depleted, therefore, only one soil gas sample was collected at the site. The soil gas sample was collected following procedures in the protocol document (Hinchee *et al*, 1992). The soil gas sample was shipped via Federal Express® to Air Toxics, Inc. in Folsom, California for TVH and BTEX analysis using EPA Method TO-3. The results of these analyses are provided in Table 4.2.

4.2.2 Exceptions to Test Protocol Document Procedures and Work Plan

Procedures described in the protocol document (Hinchee *et al.*, 1992) were used to complete pilot tests at UST 702. The only exceptions were that thermocouples were not installed in the MPs, and helium was not used during the respiration testing. Because the groundwater is very shallow, it was necessary to perform an "area" respiration test; therefore, helium was not used.

Because most of the contaminated soil was removed during tank removal activities, a limited area of contamination remains adjacent to the former tank excavation. Because existing monitoring well TW1601 is near the localized extent of contamination, this well was used as a VW. Therefore, a VW was not installed as proposed in the work plan. Because the contamination is so shallow and localized, only one soil gas sample and three soil samples were collected.

4.3 Pilot Test Results

4.3.1 Initial Soil Gas Chemistry

Prior to initiating any air injection, soil gas in the VW (TW1601), all MPs, and three other existing groundwater monitoring wells (TW1602 through TW1604, see Figure 4.1) was analyzed for initial oxygen, carbon dioxide, and TVH concentrations using portable gas analyzers, as described in the technical protocol document (Hinchee et al., 1992). Table 4.3 summarizes the initial soil gas chemistry. The VW, MPs, and MWs were purged until oxygen levels had stabilized to remove stagnant gas prior to collecting soil gas samples.

TABLE 4.2
SOIL AND SOIL GAS ANALYTICAL RESULTS
UST 702
EAKER AFB, ARKANSAS

Analyte (Units)[a/]	Sample Location-Depth (feet below ground surface)			
Soil Gas Hydrocarbons	MPB-5			
TVH[b/] (ppmv)	48			
Benzene (ppmv)	0.020			
Ethylbenzene (ppmv)	0.12			
Toluene (ppmv)	0.12			
Xylenes (ppmv)	22			
Soil Hydrocarbons	MPA-6.5	MPB-5.5	MPC-5.5	
TEPH - diesel[c/] (mg/kg)	640	4,200	370	
Benzene (µg/kg)	< 2.3	< 57	< 2.2	
Toluene (µg/kg)	< 2.3	< 57	< 2.2	
Ethylbenzene (µg/kg)	6.5	560	41	
Xylenes (µg/kg)	25	750	67	
Soil Inorganics	MPA-4	MPA-5.5	MPC-4	BG-2.5[d/]
pH (pH units)	5.8	6.0	5.8	---
Iron (mg/kg)	12,000	17,300	14,800	---
Alkalinity (mg/kg)	55.5	< 27.8	< 27.8	---
TKN (mg/kg)	151	180	147	< 4.6
Phosphorus (mg/kg)	< 2.1	<2.2	< 2.1	---
Soil Physical Parameters	MPA-4	MPA-5.5	MPC-4	
Moisture (% wt.)	9.9	10.3	10.3	
Gravel (%)	0.0	0.0	0.0	
Sand (%)	44.0	16.0	18.4	
Fines (Silt and Clay) (%)	66.0	84.0	81.6	

a/ ppmv=parts per million, volume per volume; mg/kg=milligrams per kilogram; µg/kg=micrograms per kilogram; TKN=total Kjeldahl nitrogen; TVH=total volatile hydrocarbons; TEPH=total extractable petroleum hydrocarbons; wt.=weight.

b/ TVH referenced as jet fuel (molecular weight=156) and analyzed by USEPA Method TO-3.

c/ TEPH analyzed for by USEPA Method SW8015 modified.

d/ --- = Not analyzed.

TABLE 4.3
INITIAL SOIL GAS CHEMISTRY
BUILDING 702
EAKER AFB, ARKANSAS

Sample Location	Screen Depth (feet)	O_2 (%)	CO_2 (%)	Field TVH (ppmv) [a/]	Laboratory TVH (ppmv) [b/]
VW1 (TW1601)	6-16	1.1[c/]	11.0[c/]	88[c/]	---[d/]
MPA	5.5	20.8	0.05	30	---
MPB	5	5.5	12.2	510	48
MPC	4.5	20.8	0.05	18	---
TW1602	6-16	20.8	0.08	10	---
TW1603	6-16	20.8	0.08	13	---
TW1604	6-16	20.8	0.08	10	---

a/ Total volatile hydrocarbon field screening results reported in parts per million, volume per volume.
b/ Laboratory total volatile hydrocarbon analytical results referenced to jet fuel (molecular weight=156).
c/ The screened interval was below groundwater; therefore, the soil gas chemistry observed during the November 16, 1995 site visit is presented.
d/ --- = Not analyzed.

At the VW and MPB, soil gas oxygen concentrations were below the atmospheric concentration of approximately 21 percent. Depleted oxygen concentrations indicate significant biological activity and soil contamination. Sampling results strongly indicate significant soil contamination at the 5-foot depth of MPB. An oxygen concentration of 5.5 percent at this location corresponds with a total BTEX concentration of 1.4 mg/kg in the soil. These results clearly indicate significant biological activity associated with contaminated soils. Initial oxygen concentrations at monitoring wells TW1602, TW1603, and TW1604, and at monitoring points MPA and MPC, were at 20.8 percent. These higher soil gas oxygen concentrations coupled with lower soil gas TVH concentrations indicate the absence of significant fuel contamination at these locations. The vadose zone contamination at UST 702 appears to be confined to a small area east of the former tank excavation (Figure 4.1).

TVH field measurements at the VW and MPs ranged from 10 to 510 ppmv, and the soil gas laboratory TVH result for MPB-5 was 48 ppmv (Table 4.3). Because of the limited extent of the contamination at UST 702, only one soil gas sample was collected for laboratory analysis.

4.3.2 Air Permeability

An air permeability test was conducted according to protocol document procedures. Air was injected into the VW for 15 hours at a rate of approximately 11 scfm and an average pressure of 36 inches of water. The maximum pressure response at each MP is listed in Table 4.4. The pressure measured at the MPs increased rapidly during the first 5 minutes of the test, then decreased for the remainder of the test. Due to the rapid pressure response, the steady-state method of determining air permeability was selected. A soil gas permeability value of approximately 10 darcys, typical for sandy, silty clay soil, was calculated for this site. A radius of pressure influence of at least 10 feet was observed. At MPB, the closest measuring point from the VW at a distance of 10 feet, the maximum pressure response was 0.46 inch of water. At MPA and MPC a slight vacuum response was observed, however this phenomena is likely the result of barometric pressure. Because of the shallow groundwater at the site during pilot testing, results obtained during the permeability test do not represent the conditions that are expected throughout the drier seasons of the year.

4.3.3 Oxygen Influence

The radius of oxygen increase in the subsurface resulting from air injection into the VW during pilot testing is the primary design parameter for full-scale bioventing system design. Optimization of full-scale and multiple VW systems require pilot testing to determine the volume of soil that can be oxygenated at a given flow rate and VW screen configuration.

Table 4.5 presents the changes in soil gas oxygen levels that occurred during a 46-day injection period using the extended pilot test blower unit. This period of air injection produced an increase in soil gas oxygen at MPB-5, the only oxygen-deficient monitoring point. Based on measured changes in oxygen levels, it is anticipated that the radius of influence for a long-term bioventing system at this site will exceed 15 feet

TABLE 4.4
MAXIMUM PRESSURE RESPONSE
AIR PERMEABILITY TEST
BUILDING 702
EAKER AFB, ARKANSAS

Location	Distance From VW1 (feet)	Screen Depth (feet bgs)[a/]	Elapsed Time to Maximum Pressure (minutes)	Maximum Pressure Response (inches of water)
MPA	13.4	5.5	910	-0.01[b/]
MPB	10.4	5	910	0.46
MPC	14.5	4.5	910	-0.015[b/]

[a/] bgs = below ground surface.
[b/] A negative pressure was observed.

TABLE 4.5
INFLUENCE OF AIR INJECTION AT VW ON MONITORING POINT OXYGEN CONCENTRATIONS
UST 702
EAKER AFB, ARKANSAS

Location	Distance From VW (feet)	Screen Depth (feet bgs) [a/]	Initial O_2 [b/] (%)	Final O_2 [c/] (%)
MPB	10.4	5	5.5	16.5

[a/] bgs = below ground surface.
[b/] Measurement taken prior to the respiration test and air injection at the VW.
[c/] Measurement taken following approximately 46 days of air injection at the VW.

at all depths. Monitoring during the extended pilot test at this site will better define the effective treatment radius.

4.3.4 *In Situ* Respiration Rates

The *in situ* "area" respiration test was performed by injecting air (oxygen) into the VW using the extended blower for a 41-hour period. Oxygen loss and other changes in soil gas composition over time were then measured at the VW and MPB-5. Initial soil gas data indicated that MPA-5.5 and MPC-4.5 were not oxygen deficient (Table 4.3); therefore, a respiration test was not conducted at these MPs. Oxygen, TVH, and carbon dioxide were measured for a period of approximately 34 hours following air injection. The measured oxygen losses were then used to calculate biological oxygen utilization rates. The results of *in situ* respiration testing for MPB-5 is presented in Figure 4.6. Table 4.6 provides a summary of the oxygen utilization and fuel degradation rates at this MP and at the VW.

Oxygen loss measured at MPB and the VW occurred at moderate rates, ranging from 0.56 percent per hour at MPB-5 to 0.67 percent per hour at the VW. At MPB-5, the oxygen level dropped from 19.4 percent to 12.8 percent in 34 hours. Following air injection, the groundwater level at the VW recovered rapidly, so only three soil gas samples were obtained prior to the screen being submerged under groundwater. Therefore, because few data were obtained from the VW, respiration results are only qualitative.

Based on these oxygen utilization rates, an estimated 990 to 1,160 mg of fuel per kg of soil can be degraded each year at this site. This conservative estimate is based on an average air-filled porosity of approximately 0.05 liter per kg of soil, and a ratio of 3.5 mg of oxygen consumed for every 1 mg of fuel biodegraded. Actual degradation rates may be slower if air flow is significantly limited by shallow groundwater conditions.

4.3.5 Potential Air Emissions

Soil concentrations of total BTEX compounds detected were less than 1.4 mg/kg; however, the majority of vadose zone contamination at UST 702 is shallow (located between 5 and 7 feet bgs). Consequently, the long-term potential for air emissions from full-scale bioventing operations at this site is considered moderate. VOC emissions should be minimal, however, because of the type and age of the site contaminants (greater than 5 years, and primarily fuel oil); the low air injection rate (11 scfm), and the localized nature of the contamination, and because vapors will move slowly outward from the air injection point and will be biodegraded as they move horizontally through the soil. To confirm this, a GasTech® total hydrocarbon vapor analyzer will be used to monitor the breathing zone during the April 1997 field event. During pilot testing at UST 702, health and safety monitoring of ambient air was not conducted because of windy conditions that would have provided biased results. Finally, the site is located next to Building 702, which is currently unoccupied and is expected to remain so until the bioventing system is dismantled.

FIGURE 4.6
INITIAL RESPIRATION TEST RESULTS AT MPB-5
UST 702
EAKER AFB, ARKANSAS

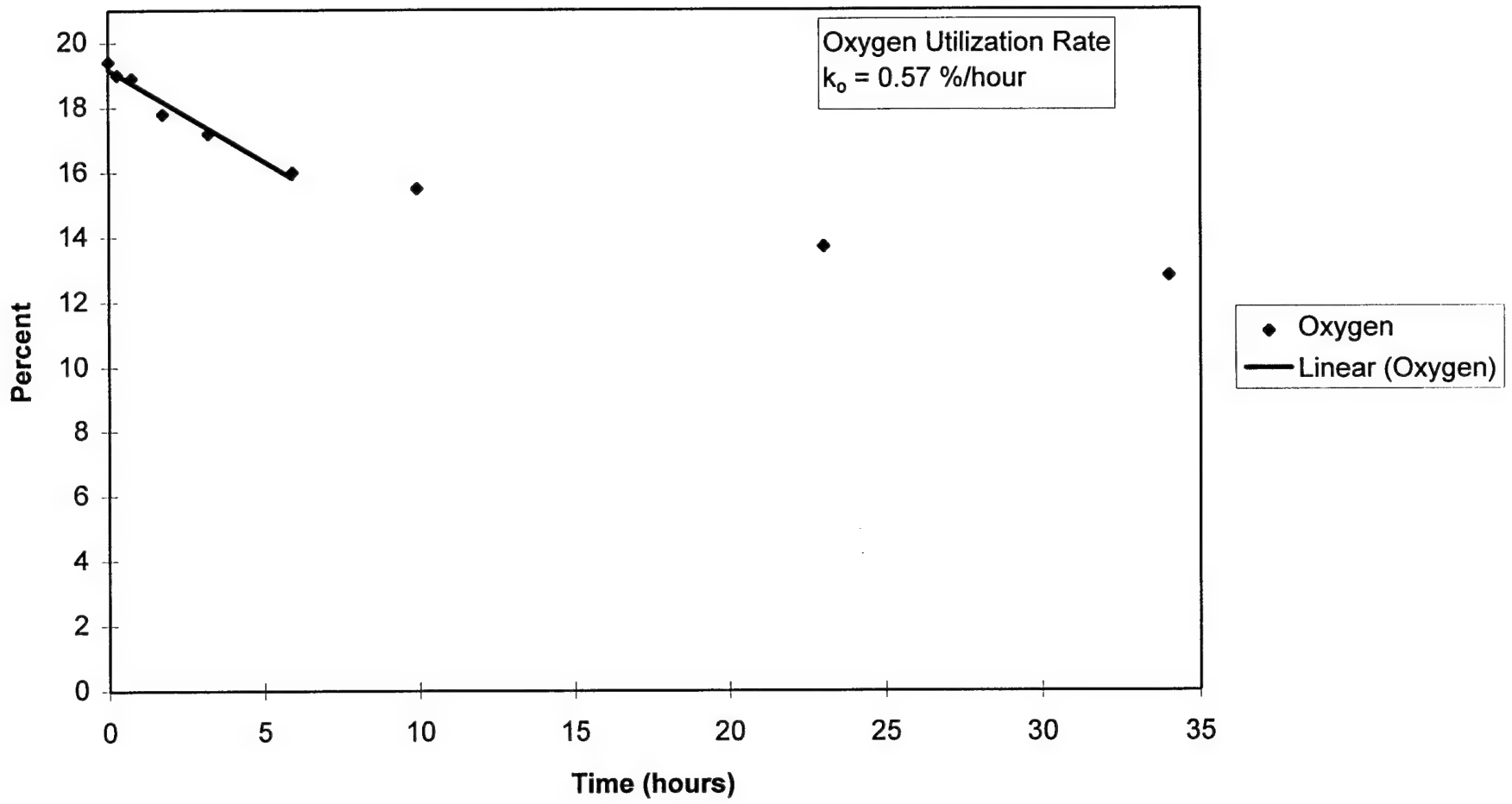

TABLE 4.6
OXYGEN UTILIZATION AND FUEL DEGRADATION RATES
UST 702
EAKER AFB, ARKANSAS

Location-Depth (feet bgs) [a/]	Test Duration (hours)	0_2 Loss (%)	O_2 Utilization Rate [b/] (%/hour)	Fuel Degradation Rate (mg TPH/kg/year)[c/]
VW 6-16	1.1	0.8[d/]	0.67	1,160
MPB-5	5.9	3.4	0.57	990

[a/] bgs = below ground surface.
[b/] Value based on best-fit line (See Figure 4.6 for MPB-5).
[c/] mg TPH/kg/year = milligrams of total petroleum hydrocarbons per kilogram of soil per year
[d/] Groundwater recovered to above the VW screened interval approximately 1 hour after oxygenation with the regenerative blower.

4.4 Recommendations

Initial bioventing tests at this site indicate that oxygen has been depleted in the remaining area of localized soil contamination near MPB, and that air injection is an effective method of increasing aerobic fuel biodegradation. It is recommended that air injection continue at this site to determine the long-term radius of oxygen influence and the effects of time and available nutrients on fuel biodegradation rates.

A small, 1-horsepower regenerative blower has been installed at the site to continue air injection at a rate of approximately 11 scfm. The 1-year test period funded under Option 1 of the Extended Bioventing Project began on April 5, 1996. Parsons ES will operate the blower through April 7, 1997, conduct radius of oxygen influence measurements on April 7, 1997, shut off the blower, and then conduct follow-up "area" respiration tests at the VW and MPB-5. Approximately 1 month later (May 1997) Parsons ES will mobilize the Geoprobe® rig to the site to perform additional soil sampling. Figure 4.7 shows the proposed additional Geoprobe® boring locations at UST 702. One soil sample from each of four soil borings will be analyzed for TEPH by USEPA Method SW8015M. All soil sampling activities will be conducted under the assumption that sampling results will eventually be used to obtain site closure. In addition, during the May 1997 field event, Parsons ES will collect a soil gas sample from MPB-5 to determine the level of cleanup achieved after 1 year of *in situ* treatment.

Results of the initial air permeability test indicate that the radius of oxygen influence exceeds 10 feet at a depth of 5 feet bgs. This, in conjunction with the localized extent of the majority of contamination (near MPB), and the placement of the VW (TW1601) near the eastern edge of the former tank excavation, is evidence that the entire volume of contaminated soil is receiving bioventing treatment. Therefore, the current bioventing pilot-scale system appears to be adequate to treat the entire volume of fuel-contaminated soil, and additional air injection points will not be necessary.

Based on the oxygen influence observed following 46 days of air injection during the "wet" season, it is anticipated that the shallow groundwater at the UST 702 site will not significantly limit the radius of oxygen influence. However, it should be noted that the bioventing technology will not treat the contaminated soils below the groundwater table. Soil sampling conducted during tank removal activities indicated that petroleum-contaminated soils were present to a depth of 17 feet bgs. Considering that the groundwater fluctuates at depths of 5 to 9 feet bgs, much of the contaminated soil will remain untreated. Therefore, an eventual risk-based site closure is recommended for UST 702. Benzene concentrations were non-detectable in soil (Table 4.2), and groundwater analytical results from downgradient monitoring wells suggest that dissolved petroleum hydrocarbon contaminants have not migrated more than 20 feet beyond the edge of the former tank excavation. The potential for off-Base migration of contaminated groundwater from the UST 702 site is considered to be very low. Therefore, the potential for downgradient receptors to be exposed to contaminants in groundwater is low, because contaminant migration appears to be minimal. It is likely that intrinsic bioremediation processes coupled with active remediation (bioventing) will continue to reduce hydrocarbon concentrations in soil and groundwater at the site.

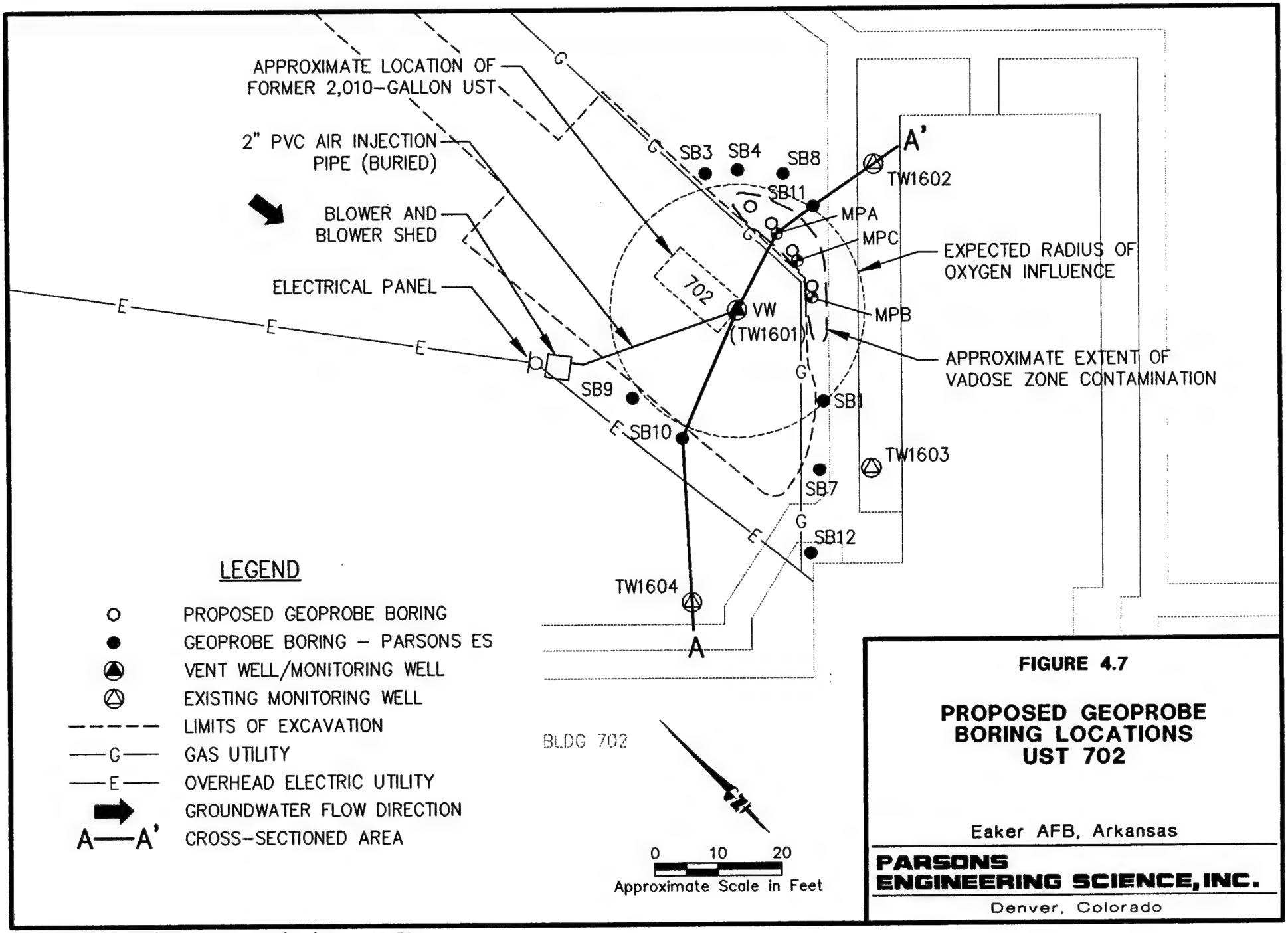

FIGURE 4.7

PROPOSED GEOPROBE BORING LOCATIONS UST 702

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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5.0 PROJECT SCHEDULE

The following schedule is contingent upon approval of the proposed additional field work. It is assumed that digging permits that were obtained for the initial pilot tests will be valid for the proposed borings at each site.

Event	Date
Oxygen Influence Measurements/System Shutdown	April 7, 1997
1-Year "Area" Respiration Testing	April 7-10, 1996
Geoprobe® Drilling/MP Installation	May 5-10, 1996
Soil Gas Sampling	May 10, 1996
System Optimization	May 10, 1996
Letter Results Report	July 11, 1996

6.0 REFERENCES

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APPENDIX A
GEOLOGIC BORING LOGS,
CHAIN-OF-CUSTODY FORMS,
TEST DATA, AND CALCULATIONS

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: SS1-SB1(VW1)
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER: Cldy, windy
DRLG MED: Direct Push

DATE: 3/20/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5			4-5': Clay, sm silt, stiff, brn/gray, moist, sm staining, petroleum odor					@5' PID=20/4.0 @5' THNA=340 ppmv
6			5-6': Clay, silty, loose, moist, pet. odor, gray staining, More contaminated @6'					@6' PID=70/1.7 @6' THNA=340ppmv
7			6-7.5' SAA 7.5-8 Silt, clayey, gray staining, strong petroleum odor, moist					@8' PID=65/4.5 @8' THNA=110ppmv
8			8-9.5 SAA except sm sand, f					@9' PID=337/2.0 THNA=2,200ppmv
9								
10								
11			10-11': SAA 11-11.5': SAA except less sand more clay, wet					@11.5' PID=53/2.8 THNA≈10,000
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: SS1-VW2
RIG TYPE: Auger
TEMPERATURE (°F):
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 10 1/4" OD
CONTRACTOR: Anderson Drilling
WEATHER:
DRLG MED:

DATE: 3/22/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5								
6			6-8': Silt & clay, gray, iron oxide staining moist, pet. odor	X				@8' PID=407/1.6
7				X				
8								
9			8-10 SAA except strong pet. odor, more silt content	X				@10' PID=369/3.0
10								
11			10-12 Silt, clayey, gray, sm iron oxide staining, moist, strong pet. odor	X				@12' PID=284/1.9
12								@12.3'
13			12-14 Silt, sm clay, gray, wet, strong pet. odor	X				@13' PID=307/1.6
14								@14' PID=347/1.3
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: SS-VW3
RIG TYPE: Auger Rig → Mobile B53
TEMPERATURE (°F): ~50°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.:
CONTRACTOR: Anderson Drilling
WEATHER: Clear, sl breeze from North
DRLG MED: 10 1/4" OD,

DATE: 3/22/96 | 3/23/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Profile	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
6	1650		6-8': Clay, fatty, sm silt, brn/gray/iron oxide staining, dense, moist, no odor.					@ 8' PID = 264/1.6
8			DUP 8-to-8-9.5': Clay, tr silt, brn, moist, sm blk staining, iron oxide staining, sl odor Fat clay!					
9			9.5-10': Silt + clay, brn/gray, sl iron oxide staining, pet. odor, moist					@ 10' PID 479/1.2
10			10-12': Silt, clayey, gray, strong pet odor, moist					
11								@ 12' PID = 62.1/1.1
12			12-13': SAA					
13			13-14': SAA except saturated					@ 13 PID = 477/1.8
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130 | CLIENT: AFCEE/Eaker AFB | DATE: 3/22/96
SITE: Spill Site No. 1 | BORING DIA.: | ELEVATION:
BORING NUMBER: SS1-VW4 | CONTRACTOR: | DATUM:
RIG TYPE: Geoprobe | WEATHER: | GEOLOGIST: D. Teets
TEMPERATURE (°F): | DRLG MED:
COMMENTS:

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	~~Laboratory~~ Sample Identification	Sample Type	PID ppmv	Remarks
10			10-12: Stiff Clay, sm silt, gray, iron oxide staining, 5m intermittent blk staining, moist, sl petroleum odor		SS1-VW4-10-11	SS1	@10'	PID=125/1.5
11							@12'	PID=133/1.6
12			12-13 Fatty clay, sm silt, gray, iron oxides, sl blk staining, v moist, strong odor		SS-UW4-12.5-13		@12.2	PID=23/1.5
13			13-14 Clay, silty, gray, wet, strong pet. odor				@13	PID=195/1.5
14			@14 Silt, clayey, gray, wet, strong odor				@14	PID=260/1.8

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet
bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample
G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130 CLIENT: AFCEE/Eaker AFB DATE: 3/22/96
SITE: Spill Site No. 1 BORING DIA.: ELEVATION:
BORING NUMBER: SS1-SB5(VW5) CONTRACTOR: DATUM:
RIG TYPE: Geoprobe WEATHER: GEOLOGIST: D. Teets
TEMPERATURE (°F): DRLG MED:
COMMENTS:

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5								
6			5-7 Clay, DRT sm silty, stiff, dense, gray, iron oxide staining, moist, no staining or odor					@7' = 2.4/2.1
7	1600		7-9 Fat Clay, sm silt, gray, iron oxide staining, sm black staining, petroleum odor, moist					@9' = 137/2.0
9								
10	1630		~~9-11 Silt~~ DRT 9-10 Clay, silty, brn/gray, V moist, sm blk staining, strong pet. odor		SS1-VW5-9.5-10.5			@10' PID = 452/1.7
11			10-11 Silt, s layer, gray, wet, strong odor					@11' PID = 375/1.2
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet
bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample
G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: SS1-MPA
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~50°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER: Cldy, sm rain
DRLG MED: Direct Push

DATE: 3/27/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
8			8-9' Silt, sl clayey, gray, strong petroleum odor, sl moist.	X	No Samples			PID@9'=345/1.0
9			TD=9'					

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet
bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample
G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: SS1-SB2 (MPB-5, MPB-8)
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/20/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5			4.5-6.5': clay, sm silt, stiff, dense, brn/gry, sl petroleum odor, moist	X				@ 6.5' THVA = 240 ppmv
6				X				
7			6.5-8.0': Silt, clayey, loose, brn/gry, sl pet. odor, moist, some sand, f	X				
8								@ 8' THVA = 200 ppmv
9			8.5-10': SAA	X				
10								@ 10' THVA = 360 ppmv
11			10.5-11': SAA 11-12': SAA except wet	X				@ 11' THVA = 4,000 ppmv PID = 471.8
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: SS1-SB3 (MPC-5 MPC-9)
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/20/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5			5.5-6.5': Clay, sm silt, dense stiff, brn, moist, sl plk staining, sl odor. Gross Contamination started 6.5' bgs	X				@5.5' THVA = 7,200 ppm
6								
7			6.5-7.5': Silt, clayey, gray, moist, strong petroleum odor	X				@7.5' THVA = 1,000
8			7.5-9': SAA	X				@8' THVA = 6,400
9								@9' THVA = 3,400
10			9.5-11.5': SAA except increasing clay content with depth. Groundwater at ~11'	X				
11								@11' THVA = >10,000 ppm
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: SS1-SD4 (MPD-5)
RIG TYPE: Geoprobe (MPD-9)
TEMPERATURE (°F): ~40°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/20/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
6			6-7.5': clay, sm silt, gray/brn, wet, strong pet. odor. Fatty clay	X				
7			7.5-8 Silt & clay, gray, moist, strong pet. odor	X				
8								
9			9-9.5': Fat clay, silty, gray, vl. moist, strong odor					@10' THVA=3,500ppmv
10			9.5-10': Silt, sm clay, v dense, moist, gray, strong pet. odor	X				@10.5' THVA=4,200
11			10-11.5': Silt, sm clay, dense, wet, gray, strong pet. odor	X				@11.5 THVA=~10,000
12								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: SS1-MPE
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~50°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER: Clear/sl cldy, sl breeze from North
DRLG MED: Direct Push

DATE: 4/4/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1			See boring logs for MPA or MPB					
10			MP screen set @ 9.5' bgs Sand set @ 9-11' bgs TD = 11' bgs		No Samples			

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68130
SITE: Spill Site No. 1
BORING NUMBER: ~~VW5~~ SS1-SB6
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~65°F
COMMENTS: Located ~50' north of ~~VW5~~ DPT & VW4

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2"
CONTRACTOR: Parsons ES
WEATHER: Clear, sl breeze from north
DRLG MED: Direct Push

DATE: 3/22/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1					No Samples			
5								
6			5-7': Fat Clay, sm silt, dense, sl moist, gray/iron oxide staining, No odor or staining	X				PID @ 7' = 14.5/1.0
7								
7-9			SAA except black stringers	X				
9								PID @ 9' = 36.0/1.2
11								
11-12			SAA	X				@ 11' PID = 41.5/1.4
12			12-13 Clay, silt, gray, iron oxide staining, wet, pet odor, no staining					GW @ approx. 12' bgs
13								@ 13' PID = 241/1.4
								TD = 13' bgs
16			Comments: Smear zone petroleum contamination only					

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

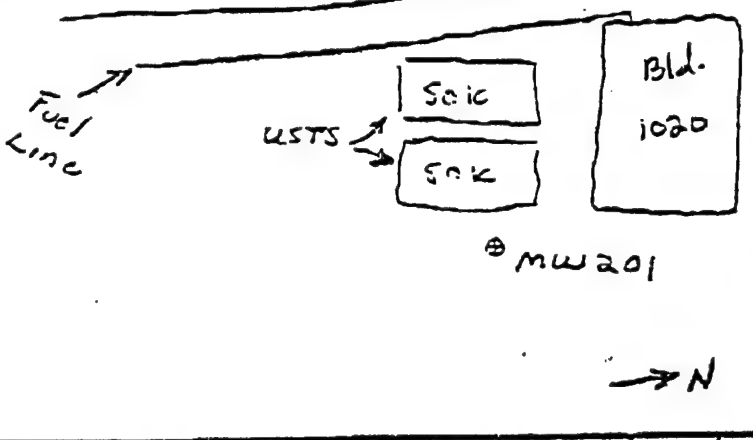
G - Grab Sample

MW201

NUS CORPORATION

FIELD LOG OF BORING SHEET 1 OF

LOCATION OF BORING: Bldg. 405



PROJECT: Site Blyth. AFB, JP-1	BORING NO.
	TOTAL DEPTH
JOB NO.: L599	LOGGED BY: A. Jer
PROJ. MGR: J. Nelson	EDITED BY: —
DRILLING CONTRACTOR: A. W. Pool	
DRILL RIG TYPE: Failing	
DRILLERS NAME: ~~A. Pool~~ G. Pool	
SAMPLING METHODS: CME cont. 55	
HAMMER WT.:	DROP: (30)
STARTED, TIME: 1030	DATE: 12/28/9
COMPLETED, TIME: 1200	DATE: ~~12~~ 12/28/9
BORING DEPTH (ft.)	
CASING DEPTH (ft.)	
WATER DEPTH (ft.)	
TIME:	
DATE:	
BACKFILLED, TIME:	DATE: BY:
SURFACE ELEV.:	DATUM: surface
CONDITIONS: clear, warm, windy	

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	SAMPLE CONDITION	DRILLING RATE (min/ft)	Analytical Sample		U.S.C.S.	DEPTH IN FEET	GRAPHIC LOG
									ML	1	
			3'	2.5'	good					2	
										3	
			5'	4.4'	good				CL	4	
4.5' 5.5'										5	
									ML	6	
							6102-SU-MW201-B			7	
			5'	4.4'	good					8	
8-9'									SM	9	
										10	

0-3'
Loam, silty, dk. brown, some mottled orange, dry to moi. mod hard

3-8'
Loam, silty to ~~sad~~, dk brown some light gray-brown mottle, moist, num. fin. rootlets, mod hard
(3-5' more clayey, hard)

8-13' Water Table ~ 8.8'
Sand, v. fine, v. silty, dk. brown, saturated, micaceous, rare v. dk brown laminae ~ .1", occ. fine ro. sept

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FIELD LOG OF BORING (CONTINUED) SHEET 2 OF 2

PROJECT: BAFB | NO. | BORING NO. 201

Site JP-1

DEPTH	TYPE	BLOWS	DRIVEN	REC'VD	COND.	O.RATE				DEPTH	GRAPHIC LOG
									SM	11	
							0.9		SM	12	
										13	
			5'	2'	poor					14	
										15	
										16	
										17	
										18	
			5'	4'	good					19	
										20	
										21	
										22	
									SM	23	
							0.9		SM	24	
										25	
										6	
										7	
										8	
										9	
										0	

13-18'
Silt, some v.f. sand, abund. silt, dk. brown, sat., micaceous, soft

18-23'
Sand, v. fine, v. silty, dk. brown micaceous, soft

Bottom 0.2' is Silt, grey, w/ num. thin v.dk. grey laminae <0.1", mod. hard

TD = 23'

⊛ - Sample to lab

NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: BAFB JP-1 site

JOB NUMBER: 6599 | PROJECT MANAGER: J Nelson

LOGGED BY: D. Henrikson | EDITED BY: J. Lewis

WELL NAME: MW-201 | DATE: 2/28

DRILLING COMPANY: A.W. Pool

EQUIPMENT: ☒ 7¼ INCH HOLLOW STEM AUGER ☐ ____ INCH ROTARY WASH | DRILLER: G. Pool | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: 0 GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: pressure steam clean

DEVELOPMENT

METHOD OF DEVELOPMENT: bailing

DEVELOPMENT BEGAN DATE: TIME:

YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: ____ GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: ____ FEET

MATERIALS USED

3 SACKS OF 12-28 SAND

____ SACKS OF Port. Type II CEMENT

____ GALLONS OF GROUT USED

____ SACKS OF POWDERED BENTONITE

25 POUNDS OF BENTONITE PELLETS

10.6 FEET OF 2 INCH PVC BLANK CASING

15 FEET OF 2 INCH PVC SLOTTED SCREEN
1 - 0.1' screw on bott. cap

25.1
- 3.0
22.1

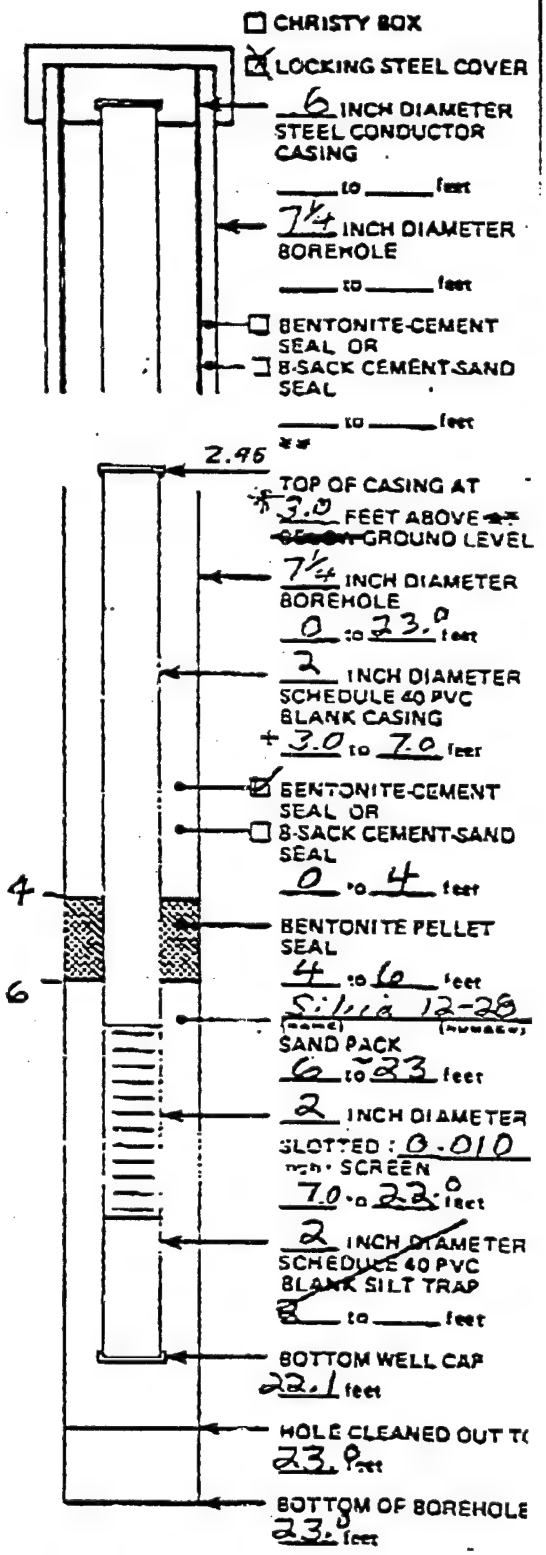
____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☒ NO ☐ YES

NAME ____

WELL COVER USED: ☒ LOCKING STEEL COVER ☐ CHRISTY BOX ☐ OTHER



NOT TO SCALE

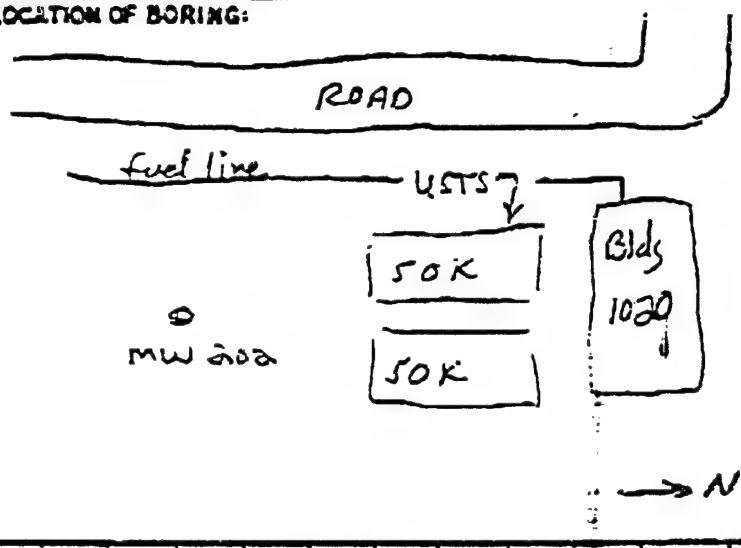
ADDITIONAL INFORMATION: riser + screen steam cleaned * prior to cut-off

NUS CORPORATION

MW202

FIELD LOG OF BORING SHEET 1 OF

LOCATION OF BORING:



PROJECT: BAFB Site JP-1	BORING NO.:
	TOTAL DEPTH
JOB NO.: 1599	LOGGED BY: A.Q
PROJ. MGR: T. Nelson	EDITED BY: J.L.
DRILLING CONTRACTOR: A. W. Pool	
DRILL RIG TYPE: Failing	
DRILLERS NAME: G. Pool	
SAMPLING METHODS: CME cont. SS	
HAMMER WT.:	DROP:
STARTED, TIME: 1350	DATE: 4/28
COMPLETED, TIME:	DATE: 4/28
BORING DEPTH (ft)	
CASING DEPTH (ft.)	
WATER DEPTH (ft.)	
TIME:	
DATE:	
BACKFILLED, TIME:	DATE: BY:
SURFACE ELEV.:	DATUM: surface
CONDITIONS:	

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	SAMPLE CONDITION	DRILLING RATE (min/ft)	Analytical Samples	U.S.C.S.	DEPTH IN FEET	GRAPHIC LOG
								CL/ML	0	
			3'	2.7'	good				1	
									2	
									3	
			5'	4.5'	good		@ 4'-5'		4	
							@ 5'-6'		5	
6.5'							@ 6'-6.5'	ML	6	
7.5'									7	
									8	
									▽ 9	
			5'	4.5'	good				10	

0-3'
CLAY, some silt, dk greenish
some org-brown mottle, mo
hard, abund. f-v. fine root

3-8'
CLAY, some silt, greenish bro
(lighter than above), much org.-b
mottle, moist, hard, abund. v.
rootlets, v. small slickensides, o
rare small angular concretion (
v. hard ↑(<.5") @ 6' bgs. Sil
same clay, dk. green w/ some or
brn. mottle, clay dec. ↓, no co
below ~6.5', moist

8-13' Water Table @ 9'
SILT, dk. green, mod. hard
soft, sat. @ ~9', @

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FIELD LOG OF BORING (CONTINUED) SHEET 2 OF 2

PROJECT: BAFB | NO. 4599 | BORING NO. 20

DEPTH	TYPE	BLOWS	DRIVEN	REC'VD	COND	D.RATE				DEPTH	GRAPHIC LOG
										11	
										12	
										13	
								0.9 7/13/96	SM	14	
										15	
			5'	2.8'	good					16	
										17	
										18	
								0.9 7/13	SM	19	
			5'	4.6'	good					20	
										21	
										22	
										23	
										24	
										25	
										6	
										7	
										8	
										9	
										0	

JP-1 site

same

@ ~ 11.5 feet bgs. SILT, w/ v.f. sand, med.-dk. brown, mod. hard to soft, sat.

13-18'

SAND, v. fine ~~soft to hard silt~~, silty dk brown, sat., soft to mod. hard, micaceous

18-23'

SAND, v. fine, ~~soft to hard silt~~ silty, dk. brown, sat., soft to mod. hard, micaceous,

TD = 23'

(*) - Sample to lab

NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: BAFB JP-1 site

JOB NUMBER: L599 | PROJECT MANAGER: J. Nielsen

LOGGED BY: A. Perkins | EDITED BY: J. Lewis

WELL NAME: MW-202 | DATE: 4/28

DRILLING COMPANY: A.W. Pool

EQUIPMENT: ☑ 7¼ INCH HOLLOW STEM AUGER | DRILLER: E. Pool

☐ ____ INCH ROTARY WASH | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: 0 GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: pressure steam cleaning

DEVELOPMENT

METHOD OF DEVELOPMENT: bailing

DEVELOPMENT BEGAN DATE: TIME:

YIELD:	TIME: FROM	TO	DATE:
____ GPM			
YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: ____ GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: ____ FEET

MATERIALS USED

3 SACKS OF 12-28 SAND

____ SACKS OF Port. Type II CEMENT

____ GALLONS OF GROUT USED

____ SACKS OF POWDERED BENTONITE

25 POUNDS OF BENTONITE PELLETS

10 FEET OF 2 INCH PVC BLANK CASING

15 FEET OF 2 INCH PVC SLOTTED SCREEN

1 - 0.1' screw on bott. cap

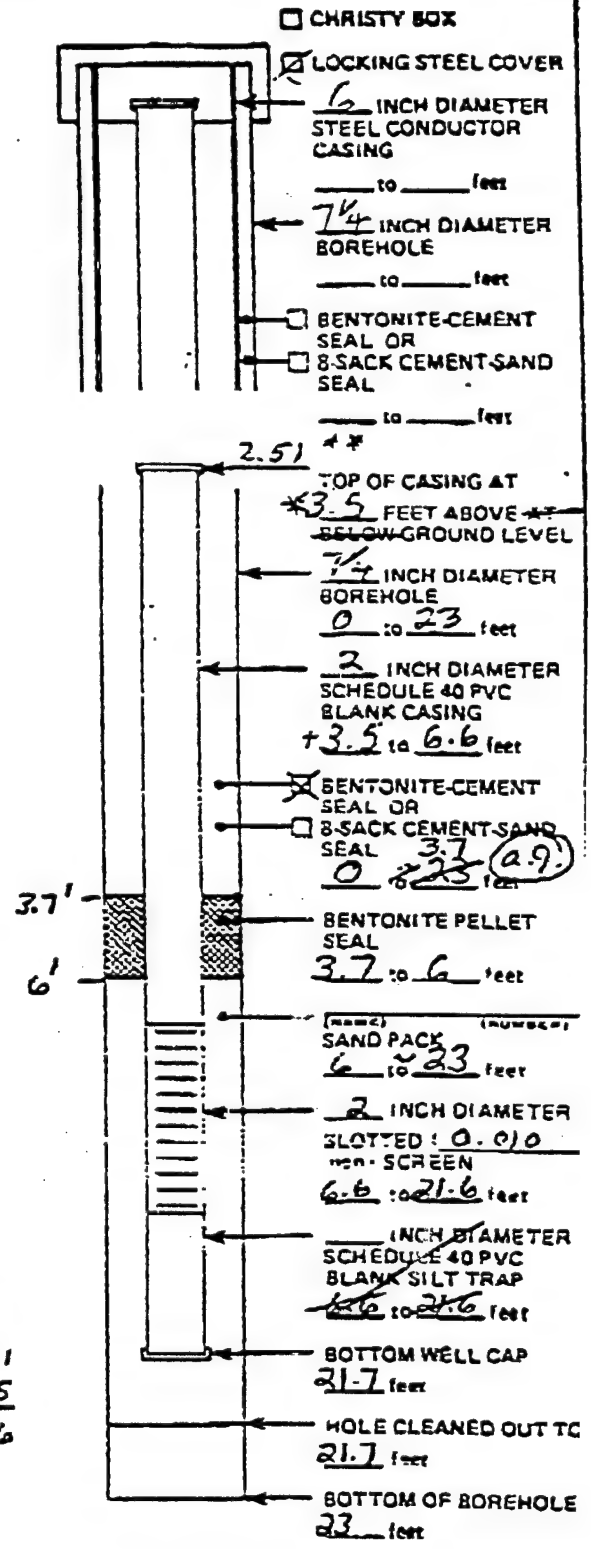
____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☒ NO ☐ YES

NAME ____

WELL COVER USED: ☑ LOCKING STEEL COVER ☐ CHRISTY BOX ☐ OTHER



25.1
-3.5
21.6

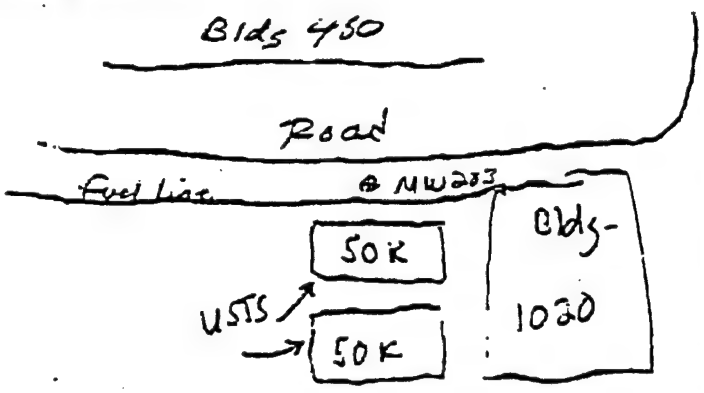
NOT TO SCALE

ADDITIONAL INFORMATION: riser + screen steam cleaned * prior to cut-off

NUS CORPORATION

FIELD LOG OF BORING SHEET 1 OF

LOCATION OF BORING:



PROJECT: Site BAFB JP-1	BORING NO. 2
	TOTAL DEPTH
JOB NO.: L549	LOGGED BY: A. Je
PROJ. MGR: J. Nelson	EDITED BY: J. Le
DRILLING CONTRACTOR: A.W. Pool	
DRILL RIG TYPE: Failing CF15	
DRILLERS NAME: G. Pool	
SAMPLING METHODS: CME cont. SS	
HAMMER WT.:	DROP:
STARTED, TIME: 0920	DATE: 4/29/8
COMPLETED, TIME:	DATE: 4/29/88
BORING DEPTH (ft.)	
CASING DEPTH (ft.)	
WATER DEPTH (ft.)	
TIME:	
DATE:	
BACKFILLED, TIME:	DATE: BY:
SURFACE ELEV.:	DATUM: surface
CONDITIONS: clear, warm (~70°F) sl. wi	

SAMPLE DEPTH	SAMPLER TYPE	BLOWS/6-IN.	INCHES DRIVEN	INCHES RECOVERED	SAMPLE CONDITION	DRILLING RATE (in/hr)		Analytical Samples	U.S.C.S.	DEPTH IN FEET	GRAPHIC LOG
			→	→					ML		
			3'	2.4'	good					1	
			↓	↓					↓	2	
			↓	↓					↓	3	
			↑						CL		
			↑							4	
			↑					MW 203-A MW 203-X		5	
			5'	4.5'	good						
			↓	↓				BL02 BL02	↓	6	
7.0										7	
(X) 8.0'											
			↑						ML	8	
			↑							9	
			5'	4.3'	good						
										10	

0-3 (finished day) LOAM, silty, dk. greenish-brown, abud. v. fine rootl
v. hard, moist, some org.-brown mottle, occ. gravel or pebble in upper 1.

3-4' CLAY, silty, dk grn-brn, some mottled org-brown, sl fine rootlets, v. hard, moist

4-8' same, but becs. dk gre no rootlets below ~6.5', num. small slickenside, distinct org- mottles, v. hard, num. v. fine dk grey frags + contorted stru below 6.5' (organics?), becs. silt

8-13' SILT, some clay, dk green some org.-brn. mottles, num. v. fi dk. grey laminae ≤ 0.1", med. ha becs. sat. ~9.7', becs. dk. g

Water Table ~ 9.7'] Below W

NUS CORPORATION

FIELD LOG OF BORING (CONTINUED) SHEET 2 OF 2

PROJECT: BAFB | NO. L549 | BORING NO. 203

site JP-1 4/29/88

DEPTH	TYPE	BLOWS	DRIVEN	REC'VD	COND.	D.RATE	USCS	DEPTH	GRAPHIC LOG
								11	
								12	
							ML	13	
								14	
			5'	3'	good			15	
								16	
								17	
								18	
								19	
			5'	4'	four good			20	
							aq 7/88 SM	21	
								22	
								23	
								24	
			5'	SD, 4'	good			25	
								26	
								27	
								28	
								9	
								0	

some f N. fine dk. lam. appear to show high L x-bedding, increase from 8' ↓, v. fine sand content inc. ↓

13-18' SILT, some v. fine sand, dk green, v. uniform, soft becs more brown ↓, sat.

18-23' SAND, v. fine, w/ some silt, dk brown, soft, sat., becs. yellow-brn ↓ & uniform

23-28' SAND, v. fine, w/some silt, dk green, abund. dark grains, v. uniform, v. soft-soft, sat. bottom 0.2' is SILT, dk ~~brn~~ grey grn w/ num. v. fine dk. lam., hard

TD = 28'

(X) duplicate samples, both to lab

NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: BAFB Site JP-1

JOB NUMBER: L599 | PROJECT MANAGER: J. Nelson

LOGGED BY: A. Jenkins | EDITED BY: J. Lewis

WELL NAME: MW 203 | DATE: 4/29/93

DRILLING COMPANY: A.W. Pool

EQUIPMENT: ☒ 7¼ OD INCH HOLLOW STEM AUGER | DRILLER: G. Pool

☐ ____ INCH ROTARY WASH | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: ○ GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: pressure steam

DEVELOPMENT

METHOD OF DEVELOPMENT: bailing

DEVELOPMENT BEGAN DATE: TIME:

YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: ____ GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: ____ FEET

MATERIALS USED

5 SACKS OF 12-28 SAND

____ SACKS OF Port. Type II CEMENT

____ GALLONS OF GROUT USED

____ SACKS OF POWDERED BENTONITE

25 POUNDS OF BENTONITE PELLETS

10 FEET OF 2 INCH PVC BLANK CASING

15 FEET OF 2 INCH PVC SLOTTED SCREEN

1-0.1' spew on batt. cap

25.1
-4
21.1

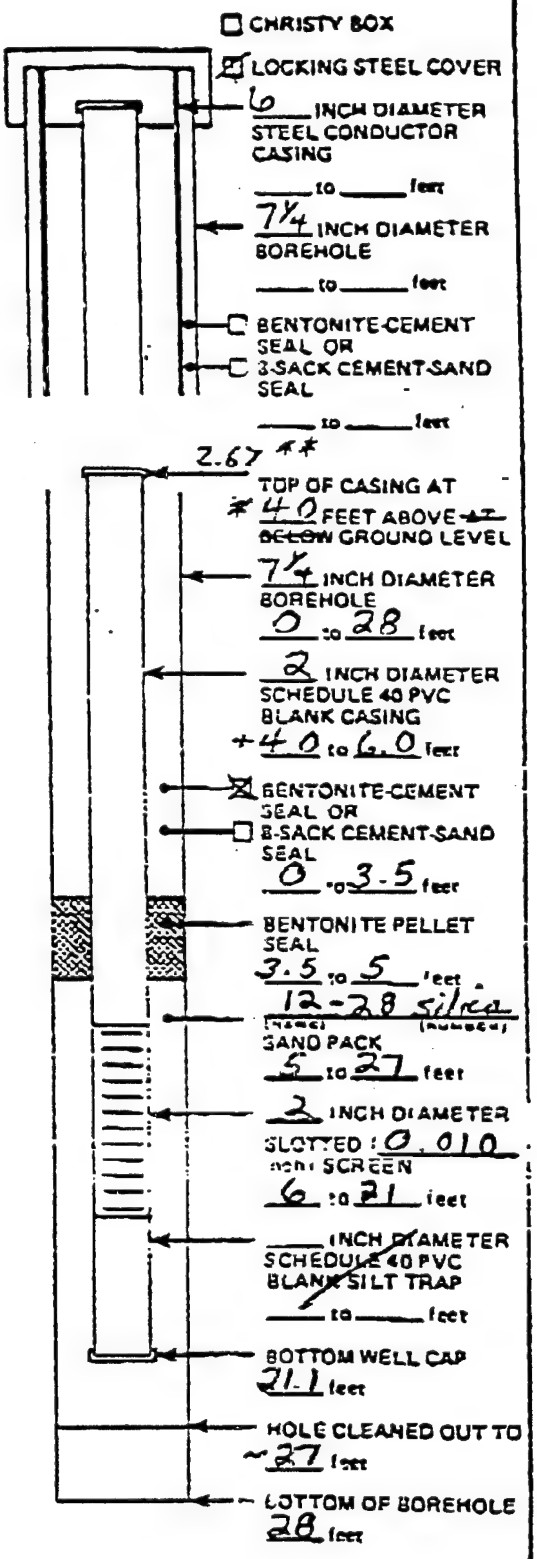
____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☒ NO ☐ YES

NAME ____

WELL COVER USED: ☒ LOCKING STEEL COVER ☐ CHRISTY BOX



NOT TO SCALE

ADDITIONAL INFORMATION:

* prior to cut-off

** After 1.33' cut off and survey completed.

Halliburton NUS CORPORATION

FIELD LOG OF BORING

WELL NO. MW205

SHEET 1 OF 2

PROJECT: EAKER AFB RFI	JOB NO.: 0114	BORING/WELL NO.: MW205	
	LOGGED BY: BDH	TOTAL DEPTH OF BOREHOLE: 21.5'	
DRILLING CONTRACTOR: Tri-State Testing		SURFACE ELEV.:	DATUM:
DRILLER'S NAME: Joe Flegger		START TIME: 1441	DATE: 4/9/95
DRILL RIG TYPE: CME-55		FINISH TIME: 1600	DATE: 4/9/95
BORING METHOD: HSA		WATER DEPTH:	
HOLE DIAMETER: 7¼"		DATE:	
SAMPLING METHOD: Continuous		TIME:	
HAMMER WGT.: NA	DROP HGT NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: Grass		WEATHER: Fair, upper 70°F, strong wind	

SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY	SKETCH OF BORING LOCATION / MATERIAL DESCRIPTION
0.5					0	dry		10YR 3/2		1	1.4	0.5' – 1.4 Clay, sl silty, very dark grayish brn, stiff; mottled orange brn, roots, dry
			2.0'	2.0'	0	sl moist				2		1.4 – 6.3' Clay, silty, dark gray, mottled orange brn, very stiff, minor roots, sl moist, less silt ~1' down into 6.3'
2.7					1			10YR 4/1		3		
										4		
			5.0'	5.0'	8					5		E01-SB-MW205A 5.2'-5.7' 30ppm clay @ 1457
					30							
						sl. moist		2.5Y 4/2		6	6.3	6.3' – 11.8' Clay, silty dark grayish brn very stiff, becomes lt olive brn (2.5Y 5/3) @ ~8.6 – 9.1' very stiff, 9.1' – 11.8' is 2.5Y 5/2
7.7										7		
					15					8		
										9		
					20	moist				10		9.7' – 10.2 E02-SB-MW205B – 20ppm 2.5Y 5/2 clay @1506 mottled orange brn

NOTES: _____

EDITED BY/DATE: _____

Halliburton NUS
CORPORATION

FIELD LOG OF BORING

WELL NO. MW205
SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: MW205

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.
					100			2.5Y		11	
			5.0	5.0	80			4/2			11.8
12.7					400	wet	soft	2.5Y 4/2		12	
					100	wet	soft			13	
			5.0	2.2						14	
										15	
					3	wet	soft			16	
17.7										17	
						wet	soft			18	
			3.8'	1.8'						14	
					3					20	
21.5										21	
										22	

dk grayish brn, mottled org. brn

11.8-21.5 Sand, very fine grnd to silt, fuel odor, wet @ 12.6
dark, grayish brn.

12.7' - 13.4' clayey sand

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: Eaker AFB

JOB NUMBER: 0114 | PROJECT MANAGER: AJ

LOGGED BY: BDH | EDITED BY:

WELL NAME: MW205 | DATE: 4/19/95

DRILLING COMPANY: Tri-State Testing

EQUIPMENT: ☒ 7¼ INCH HOLLOW STEM AUGER ☐ ____ INCH ROTARY WASH | DRILLER: Joe Flagg | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: NA GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: Steam Clean

DEVELOPMENT

METHOD OF DEVELOPMENT: SEE WELL DEVELOPMENT FORM

DEVELOPMENT BEGAN DATE: TIME:

YIELD:	TIME: FROM	TO	DATE:
____ GPM			
____ GPM			
____ GPM			
____ GPM			

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: FEET

MATERIALS USED

10.5 SACKS OF ~~#5~~ 20/40 silica bag Morie SAND

____ SACKS OF ____ CEMENT

____ GALLONS OF GROUT USED

____ SACKS OF POWDERED BENTONITE

75 POUNDS OF BENTONITE PELLETS

11.7 ~~10.0~~ FEET OF 2 INCH PVC BLANK CASING

~~10.0~~ 10.0 FEET OF 2 INCH PVC SLOTTED SCREEN 55

2.0 feet of 2 inch SS slot trap

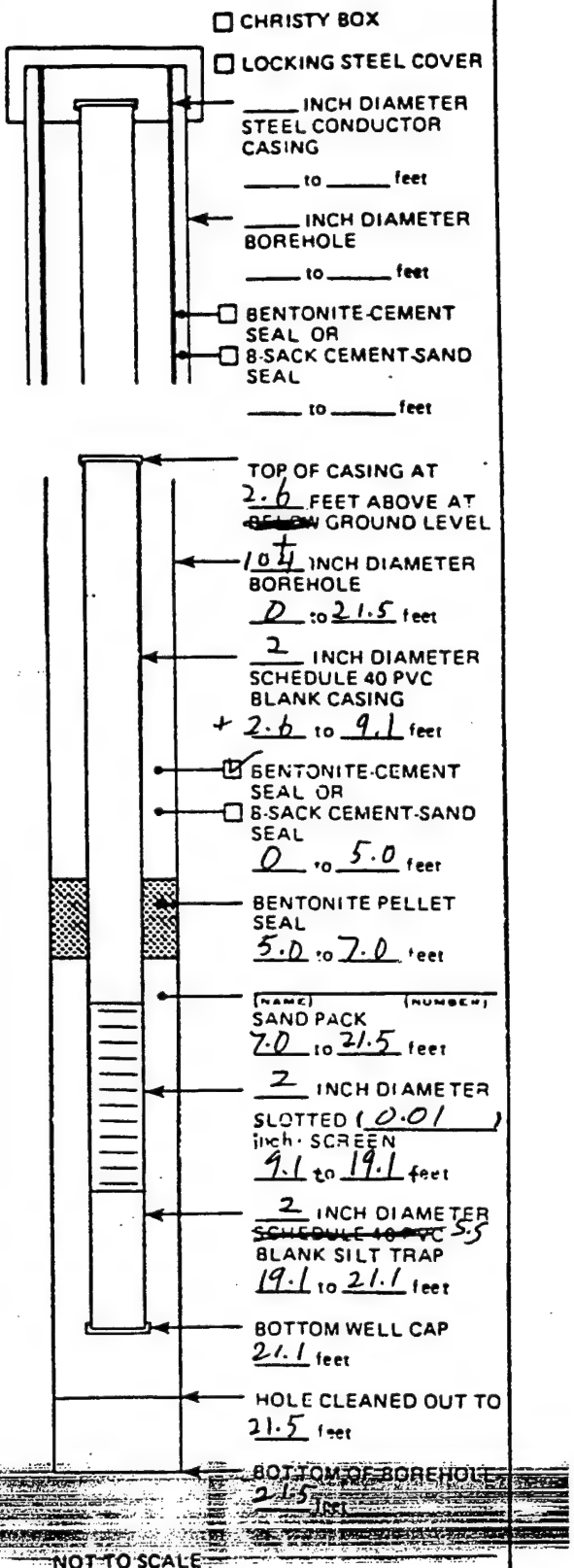
____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☐ NO ☐ YES

NAME ____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☐ OTHER ____



NOT TO SCALE

ADDITIONAL INFORMATION: ____

Halliburton NUS CORPORATION

FIELD LOG OF BORING

WELL NO. MW206

SHEET 1 OF 2

PROJECT: EAKER AFB RFI	JOB NO.: 0114	BORING/WELL NO.: MW206	
	LOGGED BY: BDH	TOTAL DEPTH OF BOREHOLE: 23.0'	
DRILLING CONTRACTOR: Tri-State Testing		SURFACE ELEV.:	DATUM:
DRILLER'S NAME: Joe Flaggs		START TIME: 1155	DATE: 4/12/95
DRILL RIG TYPE: CME-55		FINISH TIME: 1303	DATE: 4/12/95
BORING METHOD: HSA		WATER DEPTH:	
HOLE DIAMETER: 7 1/4"		DATE:	
SAMPLING METHOD: Continuous		TIME:	
HAMMER WGT.: NA	DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: grass		WEATHER: Partly cloudy, lo 70°F, strong SE wind	

SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY	MATERIAL DESCRIPTION
0.5						dry	very stiff	10YR 6/3		1	0.8	0 - 0.8' Clay, silty, pale brown, mottled yellow brn, dry, very stiff.
↓ 2.8			2.3'	2.3'	0	moist	stiff	10YR 4/1		2		0.8' - 6.7' Clay, slightly silty, dark gray, mottled orange brown,
										3		
			5.0'	5.0'	4	moist	firm			4		4.3'-4.8' E02-54-MW206A @ 1155
										5		
					3	moist	soft	10YR 3/1		6	6.7	6.7' - 7.4' Sand, very fine grnd, very dark gray
7.8			5.0'	5.0'	12					7	7.4	
					20			10YR 4/1		8		7.4' - 15.4' Clay, slightly silty, dark gray, mottled orange brn, moist
↓					12	moist	firm			9		firm
					7							
					80					10		

SKETCH OF BORING LOCATION

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS
CORPORATION

FIELD LOG OF BORING

WELL NO. MW206

SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: MW206

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.
					80	very moist				11	
↓					150	moist	firm				
12.9										12	
			5.0'	5.0'						13	
↓					150					14	
					150						
↓					4	wet	soft	10YR 5/1		15	15.4
					3					16	15.9
						moist	firm	2.5Y 4/1		17	
17.8										18	
										19	19.2
↓			5.0'	5.0'		wet	soft	2.5Y 6/3		20	20.2
					1						20.8
					0	moist	firm	2 3/10B		21	
↓					2	wet	soft	2.5Y 6/3		22	
22.8										23	

11.3' - 11.8' EO2-54 - MW206B @ 1205

15.4' - 15.9' Clay, silty laminae, gray, mottled orange brn, wet, soft

15.9' - 19.2' Clay, slightly silty, dark gray, mottled orange brn.

19.2' - 20.2' Silt, clayey, laminated light yellowish brown.

20.2' - 20.8' Clay, sl. silty, dark bluish gray, mottled reddish brn.

20.8' - 23.0' Sand, very fine grained, wet, soft, light yellowish brn.

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: Eaker AFB

JOB NUMBER: 0114 | PROJECT MANAGER: AJ

LOGGED BY: BDH | EDITED BY:

WELL NAME: MW206 | DATE: 4/12/95

DRILLING COMPANY: Tri-State Testing

EQUIPMENT: ☒ 14 ID INCH HOLLOW STEM AUGER | DRILLER: Joe Hoggard

☐ _____ INCH ROTARY WASH | HOURS DRILLED: 10

GALLONS OF WATER USED DURING DRILLING: NA GALLONS NA

METHOD OF DECONTAMINATION PRIOR TO DRILLING: Bean Water

DEVELOPMENT

METHOD OF DEVELOPMENT:

DEVELOPMENT BEGAN DATE: TIME:

YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER _____

DEPTH TO WATER AFTER DEVELOPMENT: FEET

MATERIALS USED

10½ SACKS OF 50lb 20/40 Morie SAND

_____ SACKS OF _____ CEMENT

_____ GALLONS OF GROUT USED

_____ SACKS OF POWDERED BENTONITE

100 POUNDS OF BENTONITE PELLETS

13.5 FEET OF 2 INCH PVC BLANK CASING

10.0 FEET OF 2 INCH PVC SLOTTED SCREEN 5.5.

2.0 feet of 2" and 5.5. abt stop

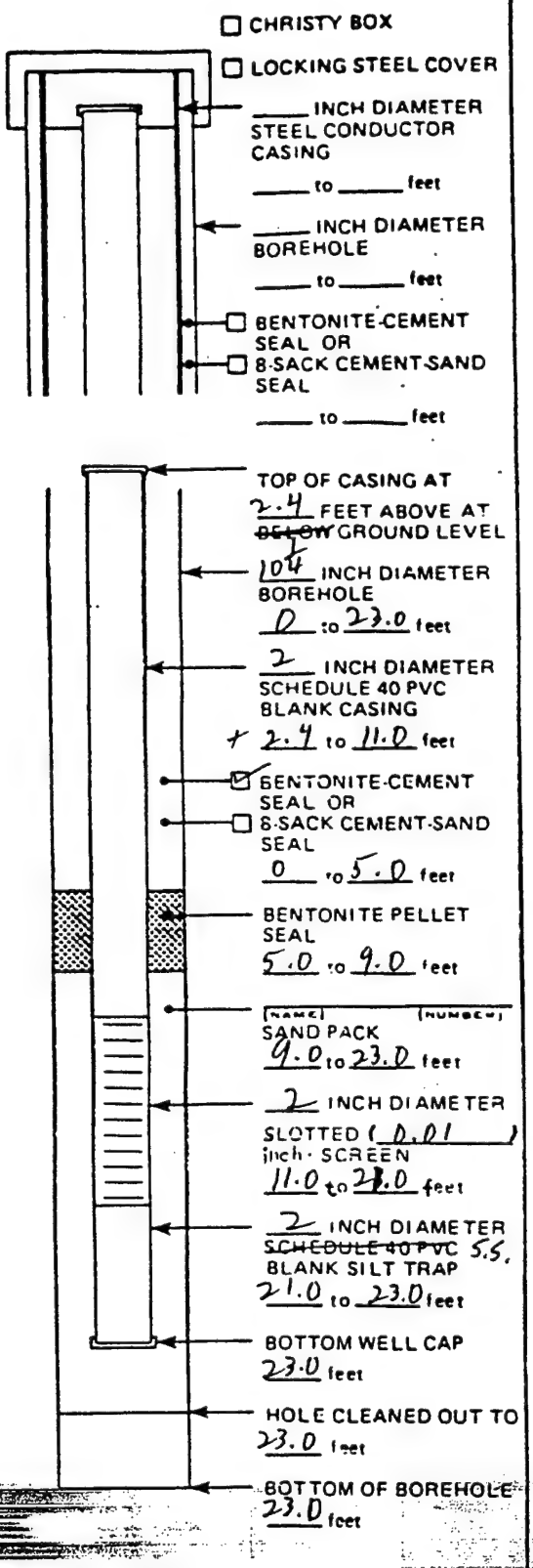
_____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

_____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☐ NO ☐ YES

NAME _____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☐ OTHER _____



NOT TO SCALE

ADDITIONAL INFORMATION: _____

Halliburton NUS CORPORATION

FIELD LOG OF BORING

WELL NO. MW207

SHEET 1 OF 2

PROJECT: EAKER AFB RFI	JOB NO.: 0114	BORING/WELL NO.: MW207	
	LOGGED BY: BDH	TOTAL DEPTH OF BOREHOLE: 23.6'	
DRILLING CONTRACTOR: Tri-State Testing		SURFACE ELEV.:	DATUM:
DRILLER'S NAME: Joe Tbogger		START TIME: 0835	DATE: 4/10/95
DRILL RIG TYPE: CME-55		FINISH TIME: 1000	DATE: 4/10/95
BORING METHOD: HSA		WATER DEPTH:	
HOLE DIAMETER: 7¼"		DATE:	
SAMPLING METHOD: Continuous		TIME:	
HAMMER WGT.: NA	DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: grass		WEATHER: Partly Cldy, lo 70°SF, ~~strong~~, gusty wnw SE	

SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY
					0	dry		2.5Y 4/2		1	
										2	
3.0										3	
										4	
			5.0'	4.0'		moist		2.5Y 6/2		5	4.4
										6	5.6
					0	moist		2.5Y 3/2		7	
8.0					3					8	
			5.0'	3.8'	60	moist		2.5Y 4/2		9	
					50	soft				10	

SKETCH OF BORING LOCATION

MATERIAL DESCRIPTION

0 - 4.4' Clay, silty, dry, stiff, w/ sorbets, dark grayish brn.

4.4' - 5.6' Sand, silty, clayey, w/ rock frags - rounded - subrounded gravel, upto 1" dian, dry, soft, lt brownish gray 4.5' - 5.0' sample # E02-54-MW207A @ 0900

5.6' - 13.2' Clay, silty, very dk grayish brown, sl. moist, very fine sand, clayey @ 6.2' - 6.3'

6.8' - 7.0' Clay is moist mottled reddish brn.

9.5' - 10' sample, 60 ppm, clay, silty, very stiff (2.5Y 4/2) dark grayish brn, mottled orgnc brn E02-54-MW207B @ 0908

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS
CORPORATION

FIELD LOG OF BORING

WELL NO. MW207

SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: | BORING NO.: MW207

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.
			5.0'	3.5'			stiff			11	
						moist				12	
13					30 280						
					3000			2.5 Y 4/2		13	13.2
						Wet	soft			14	
					110					15	
			5.0	3.4	300					16	
18										17	
			5.0	2.8						18	
					0					19	
										20	
										21	
23										22	
										23	
										24	

13.2' - 23.6' Sand, very fine grained w/ silt, well sorted, soft, wet, dark grayish brn. Strong fuel odor.

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: Eielson AFB

JOB NUMBER: 0114 | PROJECT MANAGER: AJ

LOGGED BY: BDH | EDITED BY:

WELL NAME: MW207 | DATE: 4/10/95

DRILLING COMPANY: Tri-State Testing

EQUIPMENT: ☑ 7¼ ID INCH HOLLOW STEM AUGER ☐ ____ INCH ROTARY WASH | DRILLER: Joe Thayer | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: NA GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: Steam Cleaner

DEVELOPMENT

METHOD OF DEVELOPMENT:

DEVELOPMENT BEGAN DATE: TIME:

YIELD: ____ GPM	TIME: FROM ____ TO ____	DATE:
YIELD: ____ GPM	TIME: FROM ____ TO ____	DATE:
YIELD: ____ GPM	TIME: FROM ____ TO ____	DATE:
YIELD: ____ GPM	TIME: FROM ____ TO ____	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: ____ GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: ____ FEET

MATERIALS USED

9½ SACKS OF 50 lb 20/40 mona SAND

____ SACKS OF ____ CEMENT

____ GALLONS OF GROUT USED

____ SACKS OF POWDERED BENTONITE

75 POUNDS OF BENTONITE PELLETS

14.1 FEET OF 2 INCH PVC BLANK CASING

10.0 FEET OF 2 INCH 5.5. PVC SLOTTED SCREEN

2.0 feet of 2 inch 5.5. slip stop

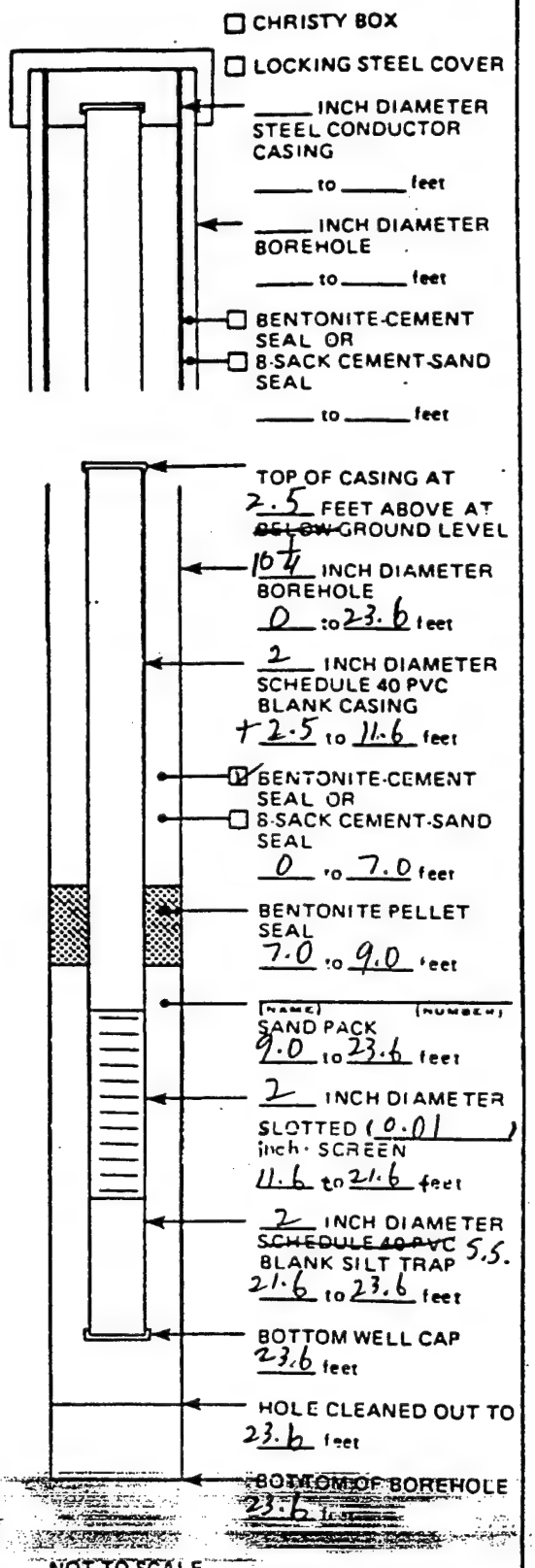
____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☐ NO ☐ YES

NAME ____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☐ OTHER ____



NOT TO SCALE

ADDITIONAL INFORMATION: ____

Halliburton NUS

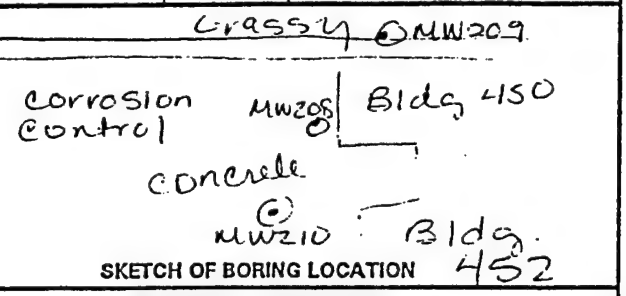
FIELD LOG OF BORING

WELL NO. MW209

SHEET 1 OF 2

CORPORATION

PROJECT: EAKER AFB RFI	JOB NO.: 6114	BORING/WELL NO.: MW209	
	LOGGED BY: G. Miller	TOTAL DEPTH OF BOREHOLE: 25'	
DRILLING CONTRACTOR: Tri-State Testing		SURFACE ELEV.:	DATUM:
DRILLER'S NAME: John Crawford		START TIME: 1001	DATE: 6/20/95
DRILL RIG TYPE: CME 75		FINISH TIME: 1550	DATE: 6/20/95
BORING METHOD: 7 1/4" HSA overdrilled w/10" HSA		WATER DEPTH:	
HOLE DIAMETER: 10"		DATE:	
SAMPLING METHOD: Continuous Sampling		TIME:	
HAMMER WGT.: NA	DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: Grassy		WEATHER: Rain, Temp 65°F.	



SKETCH OF BORING LOCATION

SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY	MATERIAL DESCRIPTION
0-5'	CS w/ liners	NA	5FT	3FT	0/0	Slt mod	Loose	10YR 4/3		1	ML	0.5' - 2.0' - SILT, some clay gravel ~1/4 inch - 1 inch; more gravel from 1.5' - 2.0'. brn.
					0/0					2		2.0' - 5.0' - Clayey SILT, dk brn.
					0/0		Slt. stiff	10YR 3/3		3		
										4		5.0' - 8.0' Silty Clay, dk grayish brn, mottled w/ 10yR 5/6 yellowish brn; root-lets.
5										5		
5			5FT	5FT	0/0			10YR 4/2		6	CL	
					0/0	Slt moist	Stiff			7		8.0 - 10.0' Clayey SILT; brn., mottled w/ 10yR 5/6 yellowish brn; less clay from 9-10'.
					0/0			10YR 5/3		8		
					0/0	Very moist SAT	Very soft		EOS-SL MW209	9	ML	10.0' - 13.0' - Silty CLAY; brn., mottled w/ 10yR 5/6 yellowish brn; clayey SILT filled root
10										10		

NOTES: To determine the extent of plume at spill site #1

EDITED BY/DATE:

Halliburton NUS CORPORATION

FIELD LOG OF BORING

WELL NO. MW209

SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: MW209

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.	
10	CS w/o Liners	NA	5FT	5FT	0/0	moist / slt. moist	Very Soft / Slt. Stiff	10YR 5/3		11		casts or worm burrows.
					0/0		Slt. Stiff			12		13.0' - 14.5' CLAY; brn. some 10YR5/6 yellowish brn. mottling.
					0/0		Soft			13	CL	
					0/0		Slt. Soft			14		14.5' - 15.- Silty CLAY; brn; less 10YR5/6 mottling than above. (yellowish brn.)
15					0/0	Very moist	Soft			15		
15			5FT	3FT	0/0	SAT	Soft	10YR 4/2		16		15.0' - 15.5' CLAY; little Silt; plastic; dk. grayish brn., less mottling than above.
					0/0	moist SAT	Very Stiff Soft			17	NK / CL	
					0/0			10YR 4/1 10YR 4/2		18	SM	15.5' - 16.5' - SILT; some sand; dk grayish brn., sand is fg; well sorted qtz; angular
										19		
20										20		16.5' - 17.0' - CLAY; dk. grayish brn., few mottles 10YR 4/6 dk yellowish brn.
20			5FT	1FT	0/0	SAT	Loose	10YR 4/4		21		
										22	SW	17.0' - 17.5' - Sandy/SILT; Silty/ SAND; Vfg; well sorted sand. dk yellowish brn.
										23		
										24		17.5' - 20.0' - as above w/ color change to 10YR 4/2 dk grayish brn.
25										25		
												20.0' - 25.0' - SAND; Vfg-fg well sorted; angular qtz; dk yellowish brn.
												TD = 25.0'

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: Eakir AFB

JOB NUMBER: 0114 | PROJECT MANAGER: Allan Jenkins

LOGGED BY: G. Millar | EDITED BY:

WELL NAME: MW209 | DATE: 10/20/95

DRILLING COMPANY: Tri State Testing Services

EQUIPMENT: ☒ 7¼ INCH HOLLOW STEM AUGER 10" overdrill HSA ☐ ____ INCH ROTARY WASH | DRILLER: J. Crawford | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: 5 GALLONS for hydration

METHOD OF DECONTAMINATION PRIOR TO DRILLING: Steam Cleaning

DEVELOPMENT See Well Development Form

METHOD OF DEVELOPMENT:

DEVELOPMENT BEGAN DATE: TIME:

YIELD:	TIME: FROM	TO	DATE:
____ GPM			
YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:
YIELD: ____ GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: FEET

MATERIALS USED

10 SACKS OF 042695 6A60NWELL Morie Sand 20/40 Filtration media SAND

____ SACKS OF ____ CEMENT

~48 GALLONS OF GROUT USED

____ SACKS OF POWDERED BENTONITE

75 POUNDS OF BENTONITE PELLETS 1.5 buckets

15.5 FEET OF 2 INCH PVC BLANK CASING

10 FEET OF 2 INCH ~~PVC~~ SS SLOTTED SCREEN

2 FT of 2inch SS. Silt trap

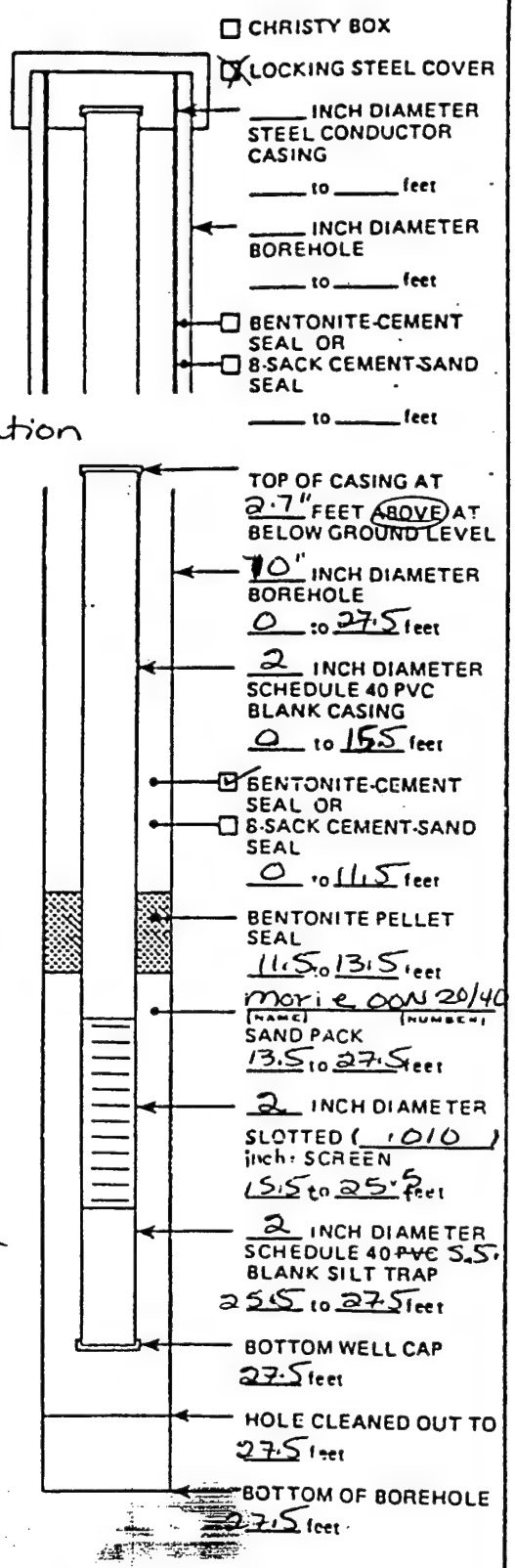
____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☐ NO ☒ YES for grout

NAME ____

WELL COVER USED: ☒ LOCKING STEEL COVER ☐ CHRISTY BOX ☐ OTHER ____



NOT TO SCALE

ADDITIONAL INFORMATION: ____

Calculated Sand = 10.92 sacks

Calculated grout = 45.08 gals

Halliburton NUS

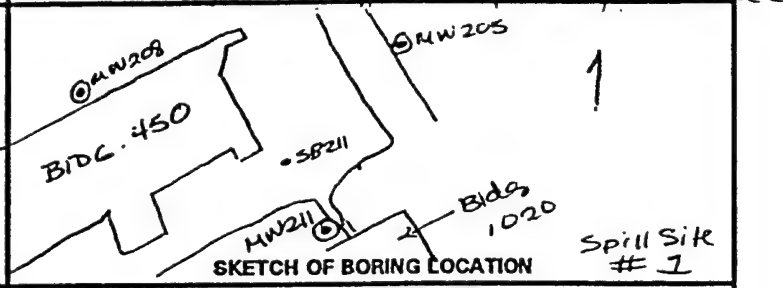
CORPORATION

FIELD LOG OF BORING

WELL NO. MW211

SHEET 1 OF 2

PROJECT: EAKER AFB RFI	JOB NO.: 0114	BORING/WELL NO.: MW211
	LOGGED BY: G. Millar	TOTAL DEPTH OF BOREHOLE:
DRILLING CONTRACTOR: Tri-State Testing	SURFACE ELEV.:	DATUM:
DRILLER'S NAME: John Crawford	START TIME: 0900	DATE: 8/15/95
DRILL RIG TYPE: CME-75	FINISH TIME: 1800	DATE: 8/15/95
BORING METHOD: 7 1/4" HSA Overdrilled W/ 10" HSA	WATER DEPTH:	
HOLE DIAMETER: 10"	DATE:	
SAMPLING METHOD: Continuous Sampling	TIME:	
HAMMER WGT.: NA DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: Grassy, patchy	WEATHER: Hot; Humid; Sunny 95°F; slt breeze	



SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY
.5	CS w/o liner	NA	3FT	2FT	0/5	Slt. moist	Loose	10YR 4/2	NO ANALYTICAL SAMPLES	1	SM
					5/20		Slt. soft to loose	10YR 3/2 to 10YR 4/2		2	
3.3			4FT	3.5	20/5					3	
					5/30	WET	Slt. soft	10YR 4/1		4	
					250/50					5	ML
					1000					6	
7			6FT	3FT	100/300		Slt. stiff			7	
					100/300					8	
					500/400	SAT		10YR 5/3		9	SM
										10	

MATERIAL DESCRIPTION

.5' - 4.0' - silty SAND; some clay, dk grayish brn; More clay from 1.5' - 1.8', vry dk grayish brn.

4.0' - 6.5' - Clayey SILT; dk gray; strong fuel odor, sheen noted; material looks like fill.

7.0' - 9.3' - silty CLAY / clayey SILT; strong fuel odor; dk gray; hit Concrete at ~ 7.0' (so fill above 7.0').

9.3' - 18.0' - silty SAND; vry fine grained; subangular well sorted; brn; slt. odor of fuel; sheen noted on surface of water along the

NOTES: To determine concentration of contaminants at the potentially most contaminated portion of the plume.

EDITED BY/DATE:

Halliburton NUS
CORPORATION

FIELD LOG OF BORING

WELL NO. NW211

SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: NW211

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.	
						SAT	LOOSE	10YR 6/3		11		barrell.
										12		
13					/							
13			5FT	1FT	200/20				NO ANALYTICAL SAMPLE B	13	SM	
										14		
										15		
										16		
										17		
18										18		TD = 21.0'
										19		
										20		

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: Eaker AFB

JOB NUMBER: 0114 | PROJECT MANAGER: Allan Jenkins

LOGGED BY: G. Millar | EDITED BY:

WELL NAME: MW 211 | DATE: 8/15/95

DRILLING COMPANY: Tri State Testing Services

EQUIPMENT: ☑ 10 INCH HOLLOW STEM AUGER | DRILLER: J. Crawford

☐ ____ INCH ROTARY WASH | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: Steam Clearing

DEVELOPMENT Well Development Form

METHOD OF DEVELOPMENT:

DEVELOPMENT BEGAN DATE: TIME:

YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: FEET

MATERIALS USED

072495 GA DONNELL

11 SACKS OF Morie 20/40 Filtration Media SAND

____ SACKS OF ____ CEMENT

20 GALLONS OF GROUT USED

____ SACKS OF POWDERED BENTONITE

75 ~~0150~~ POUNDS OF BENTONITE PELLETS 1 1/2 buckets

15 FEET OF 2 INCH PVC BLANK CASING w/ 2.5 ft. cutoff.

10 FEET OF 2 INCH ~~PVC~~ S.S. SLOTTED SCREEN

2 FT of 2 inch S.S. silt trap

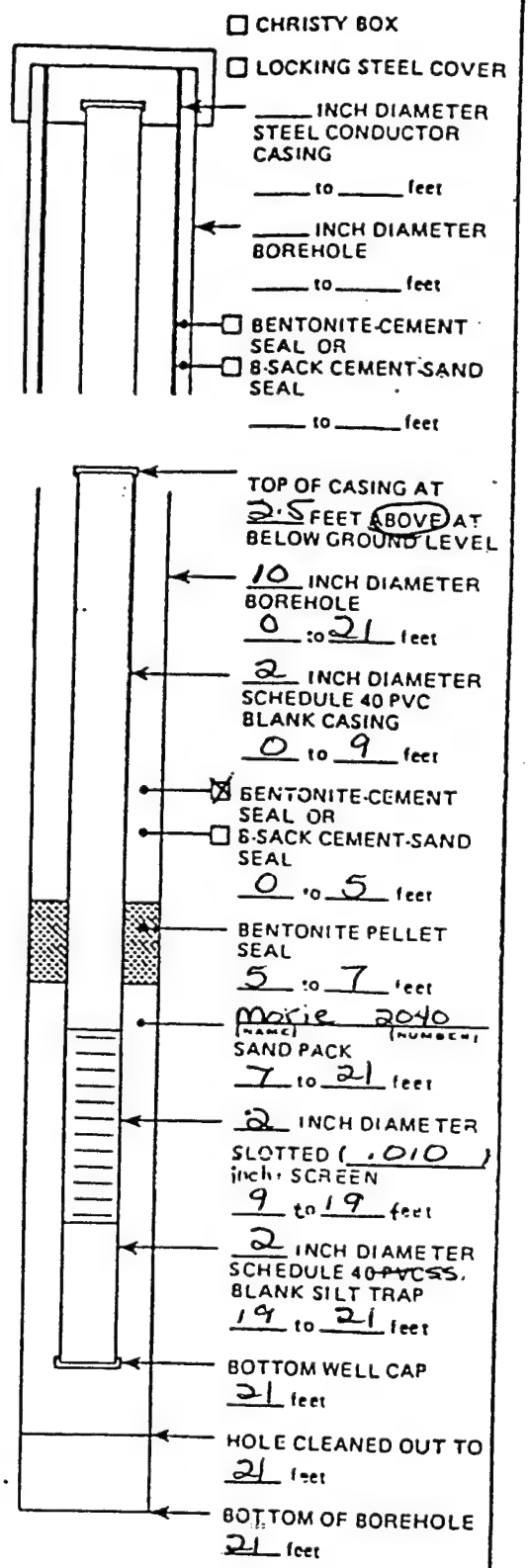
____ YARD^3 CEMENT-SAND (REDI-MIX) ORDERED

____ YARD^3 CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☒ NO ☐ YES

NAME mixed in a 55 gal.

WELL COVER USED: ☒ LOCKING STEEL COVER ☐ CHRISTY BOX ☐ OTHER ____



NOT TO SCALE

ADDITIONAL INFORMATION: ____

Calculated sand = 10.92 sacks

Calculated grout = 19.6 gal

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68230
SITE: Building 457 Area
BORING NUMBER: 457-SB1
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS: Exploratory boring (22' northwest of TW1501)

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER: v cldy, windy
DRLG MED: Direct Push

DATE: 3/18/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
7			7-9' Clay, v silty, brn, saturated, no staining or odor	X				@9' PID = 2.0/2.0

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet
bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample
G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68230
SITE: Building 457 Area
BORING NUMBER: 457-SB2
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS: Exploratory boring (~20' northwest of TW1504)

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/18/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
5			5-6': Clay, v silty, tr sand, f, brn, moist, blk stringers, no odor or staining	X				@6' PID = 1.4/1.4
6			6-7': SAA, except wet	X				@7' PID = 1.6/1.4
7				X				

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68230
SITE: Building 457 Area
BORING NUMBER: 457-SB3 (MPB-5)
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/18/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5								
6			5-7' bgs Silt, clayey, tr sand, f, brn, gray staining, strong petroleum odor, moist					
7			7-8' Silt, v clayey, moist, gray staining, brn, strong petroleum odor					@7' PID=54/2.0
8			8-8.5' Clay, v silty, v. moist, brn, gray staining, strong pet. odor					@8' PID=40/2.0
9								@8.5' PID=10/2.0
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68230
SITE: Building 457 Area
BORING NUMBER: 457-SB4(MPA-55')
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER: sl cldy, wi-dy
DRLG MED: Direct Push

DATE: 3/19/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5								
6			5-6.5': Clay, silty, tarn, moist, gray staining, strong petroleum odor. Contamination starts at about 5.2' bgs	X				@5' PID=24/1.0 THVA=84ppmv
7								
8			7-9': SAA, except wet	X				@7' PID=10.5/2.0
9								
10			9-11': SAA except saturated	X				@11' PID=12.6/1.8
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68230
SITE: Building 457 Area
BORING NUMBER: 457-SB5
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS: No monitoring point installed

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/19/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5			4-6': Clay, silty, sm sand, f-m, brn/sm gry, moist, sl staining, no odor	X			e4.5	PID=2.8/1.6
6				X				
7			6-7': SAA except no sand, wet	X			e6.5	PID=2.3/1.6
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68230
SITE: Building 457 Area
BORING NUMBER: 457-SB6(MPC-45)
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~40°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER: sl cldy, windy
DRLG MED: Direct Push

DATE: 3/19/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5			4-5.5': Clay, silty, tr. sand, f, gray/brn staining, sl. petroleum odor, moist	X				
6				X				@6' PID=1.8/1.0 THA=130ppmv
7			6-8': SAA except wet, less sand	X				@7.5' PID=20.0/1.2 THA=180ppmv
8				X				
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

Halliburton NUS

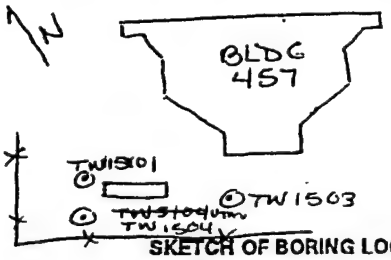
CORPORATION

FIELD LOG OF BORING

WELL NO. TW1501

SHEET 1 OF 2

PROJECT: EAKER AFB RFI	JOB NO.: 0114	BORING/WELL NO.: TW1501	
	LOGGED BY: G. Millar	TOTAL DEPTH OF BOREHOLE: 16.5'	
DRILLING CONTRACTOR: Tri-State Testing		SURFACE ELEV.:	DATUM:
DRILLER'S NAME: Mark Totty		START TIME: 1040	DATE: 8/27/95
DRILL RIG TYPE: CME-55		FINISH TIME: 1120	DATE: 8/27/95
BORING METHOD: 7¼" HSA		WATER DEPTH:	
HOLE DIAMETER: 7¼"		DATE:	
SAMPLING METHOD: Continuous Sampling		TIME:	
HAMMER WGT.: NA	DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: Grassy; Some gravel		WEATHER: Sunny; Hot; breezy 88°F	



SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY	MATERIAL DESCRIPTION
										1		* Lithology for this temp well begins at 8.0'. Lithology from .5'-8.0' is similar to that of ~~TW1501~~ TW1504 (from soil cuttings). See page 2 for lithology.
										2		
										3		
										4		
										5		
										6		
										7		
										8		
8	CS w/o Liners	NA	5FT	2.7'	5/5	SAT	Very Soft	10YR 4/4		9	SM	
					0/0	6/				10		

NOTES: To determine extent of contamination from UST at Bldg 457.

EDITED BY/DATE:

Halliburton NUS CORPORATION

FIELD LOG OF BORING

WELL NO. TW1501

SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: TW1501

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.	
					0/0					11		8.0'–13.0' – Sandy SILT / Silty SAND; some clay, sand is vfg dk yellowish brown.
						WET SOAKING				12		
13												
13			3.5	3.6	0/0					13		13.0'–16.5' – clayey SILT; some sand, more sand from 14.5'–16.0'; sand is vfg, well sorted; has a laminated appearance w/ 10yR 4/6 mottling (dk yellowish brn.) Color change to greenish grey @ 15.5'; Less sand below 16.0'; rootlets worm burrows from 13.0'–16.0', No mottling ~~arm~~ below 16.0'.
					0/0					14	ML	
					0/0			Grey 6/5GY		15		
16.5					0/	moist	saturated			16		
										17		TD = 16.5

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: Eaker AFB

JOB NUMBER: 0114 | PROJECT MANAGER: Allan Jenkins

LOGGED BY: G. Millar | EDITED BY:

WELL NAME: TW1501 | DATE: 8/27/95

DRILLING COMPANY: Tri State Testing Services

EQUIPMENT: ☑ 7¼ INCH HOLLOW STEM AUGER ☐ ____ INCH ROTARY WASH | DRILLER: M. Totty | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: 5 GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: Steam Cleaning

DEVELOPMENT See Well Development Form

METHOD OF DEVELOPMENT:

DEVELOPMENT BEGAN DATE: TIME:

YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: FEET

MATERIALS USED

5 3/4 SACKS OF ____ SAND

NA SACKS OF ____ CEMENT

NA GALLONS OF GROUT USED

NA SACKS OF POWDERED BENTONITE

75 POUNDS OF BENTONITE PELLETS 1.5 buckets

10 FEET OF 2 INCH PVC BLANK CASING 1 Ft of cut off.

10 FEET OF 2 INCH PVC SLOTTED SCREEN

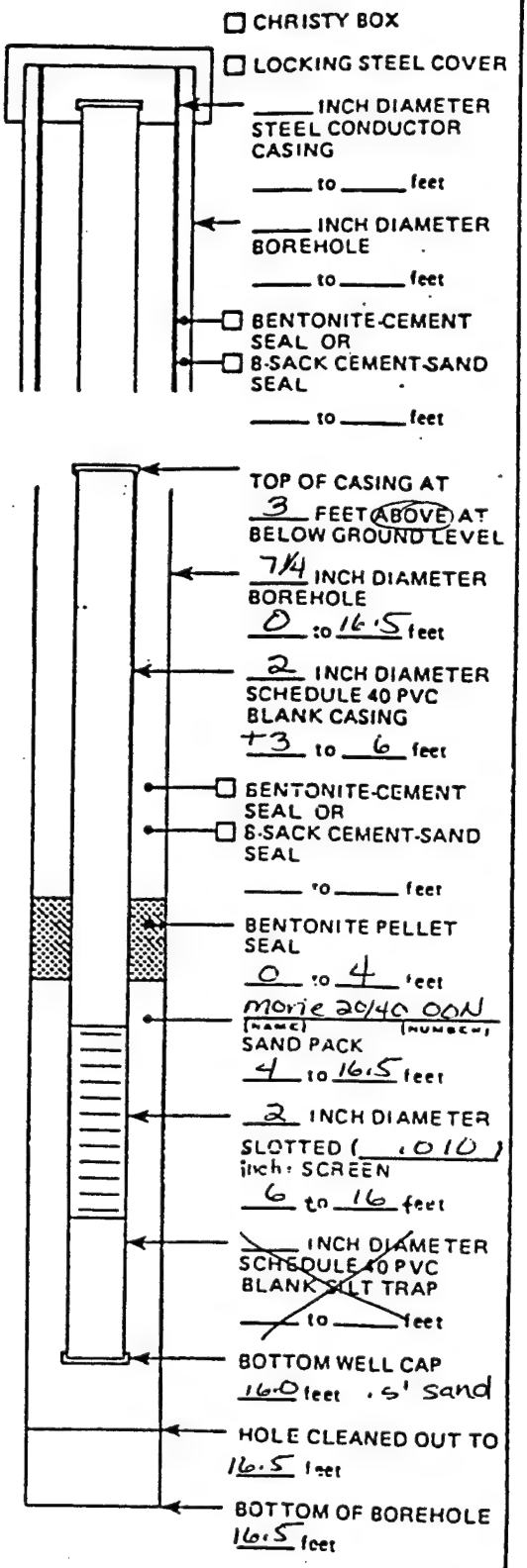
____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☒ NO ☐ YES

NAME ____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☒ OTHER Temp Well



NOT TO SCALE

ADDITIONAL INFORMATION: ____

calculated sand = 6.25 bags

Halliburton NUS

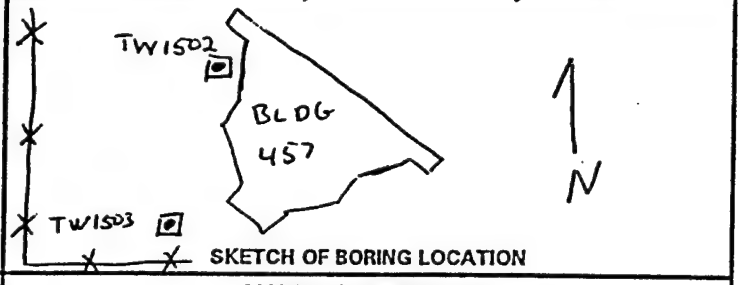
CORPORATION

FIELD LOG OF BORING

WELL NO. TW1502

SHEET 1 OF 2

PROJECT: EAKER AFB RFI	JOB NO.: 0114	BORING/WELL NO.: TW1502	
	LOGGED BY: B. McCANLESS	TOTAL DEPTH OF BOREHOLE: 18.5	
DRILLING CONTRACTOR: Tri-State Testing		SURFACE ELEV.:	DATUM:
DRILLER'S NAME: MARK TOTTY		START TIME: 0926	DATE: 8/28/95
DRILL RIG TYPE: CME 55		FINISH TIME: 1021	DATE: 8/28/95
BORING METHOD: 7 1/4" HSA		WATER DEPTH:	
HOLE DIAMETER: 7 1/4"		DATE:	
SAMPLING METHOD: SPLIT BARREL W/LINERS		TIME:	
HAMMER WGT.: NA	DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: VEGATATION		WEATHER: CLEAR, BREEZE, 80's	



SKETCH OF BORING LOCATION

SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY	MATERIAL DESCRIPTION
0	SB w/ liner	NA	5'	1.5'	0/1	DRY	loose	10YR 6/3		1	GM	0.5-3.5 FILL, silt matrix, pea gravel, roots, pale brown,
					0	MST	STF	10YR 3/1		2		very dark gray at 1.5'
										3		3.5-9.5' SILT, trace vfg sand,
5								10YR 4/6		4	ML	dark yellowish brown
5			3'	2'	0/0					5		
					0/0				E15-SU-TW1502	6		
8										7		
8			2'	2'	3/5	WET	SOFT			8		9.5-11.5 sandy SILT, sand is vfg
10					5/4	SAT				9		dark yellowish brown, no odor
											ML	

NOTES: DETERMINE PRESENCE OR ABSENCE OF CONTAMINATION

EDITED BY/DATE:

Halliburton NUS CORPORATION

FIELD LOG OF BORING

WELL NO. TW1502

SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: TW1502

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.	
LO	SB	NA	5'	4'	0%	SAT	SOFT	10YR 4/6				11.5 - 15.5 silty CLAY, gray. Some areas clayey SILT
					0%			10YR			CL	
					0%			5/1				roots at 12.5'
					0%							13.5 - 14' 2.5YR mottle (red)
15												
15			3.5'	3.5'	0%	MST	MED	CLEY				15.5 - 18.5' CLAY, trace silt
					0%		STF	6/1GY			OL	greenish grey, 5YR 4/4 (reddish brown) mottles, root structures, slightly plastic
					0%							
18.5					0							TD - 18.5'

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: EAKER AFB

JOB NUMBER: 0114 | PROJECT MANAGER: ALLAN JENKINS

LOGGED BY: B. McCANLESS | EDITED BY:

WELL NAME: TW1502 | DATE: 8/28/95

DRILLING COMPANY: TRI STATE TESTING

EQUIPMENT: ☑ 7 1/4 INCH HOLLOW STEM AUGER | DRILLER: M. JOTTY

☐ ____ INCH ROTARY WASH | HOURS DRILLED: 1

GALLONS OF WATER USED DURING DRILLING: 5 GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: STEAM CLEAN

DEVELOPMENT

METHOD OF DEVELOPMENT: SEE DEVELOPMENT FORM

DEVELOPMENT BEGAN DATE: TIME:

YIELD: ____ GPM	TIME: FROM ____ TO ____	DATE:	
YIELD: ____ GPM	TIME: FROM ____ TO ____	DATE:	
YIELD: ____ GPM	TIME: FROM ____ TO ____	DATE:	
YIELD: ____ GPM	TIME: FROM ____ TO ____	DATE:	

TOTAL WATER REMOVED DURING DEVELOPMENT: ____ GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: ____ FEET

MATERIALS USED

5 SACKS OF MORIE CO. FILTRATION MEDIA SAND

NA SACKS OF ____ CEMENT

NA GALLONS OF GROUT USED

NA SACKS OF POWDERED BENTONITE

87 POUNDS OF BENTONITE PELLETS 1.34 BUCKETS

10 FEET OF 2 INCH PVC BLANK CASING

10 FEET OF 2 INCH PVC SLOTTED SCREEN

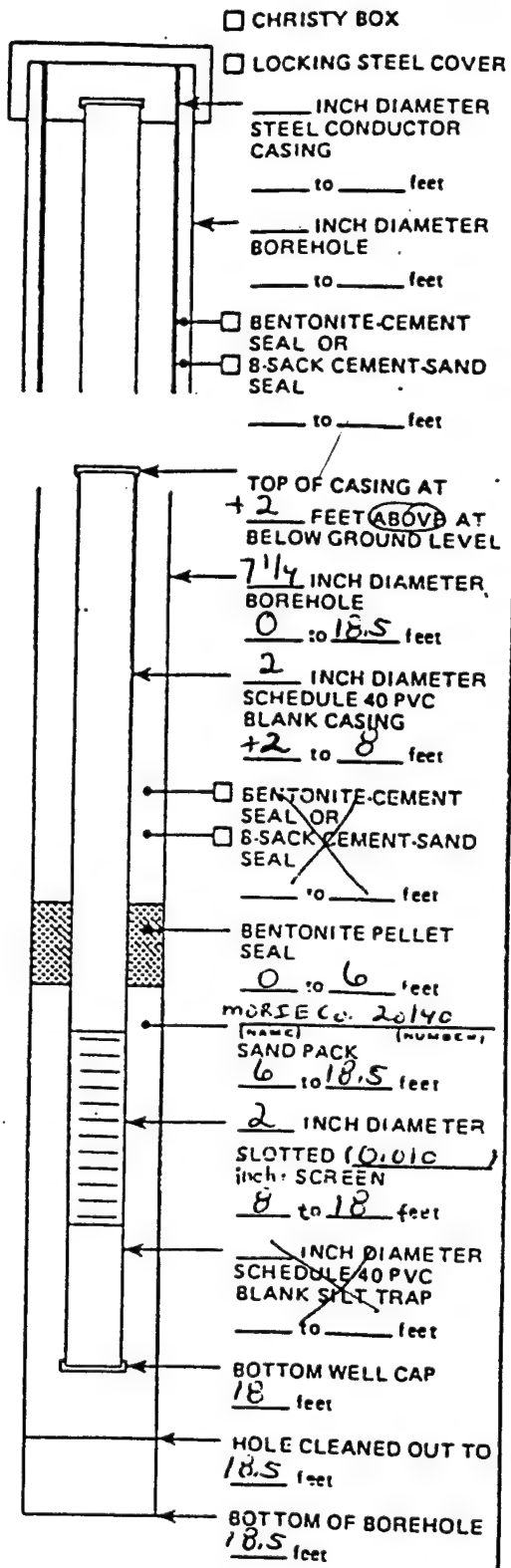
____ YARD^3 CEMENT-SAND (REDI-MIX) ORDERED

____ YARD^3 CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☑ NO ☐ YES

NAME ____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☑ OTHER TEMPORARY WELL



NOT TO SCALE

ADDITIONAL INFORMATION: CALCULATED SAND = 6.25 BAGS

Halliburton NUS

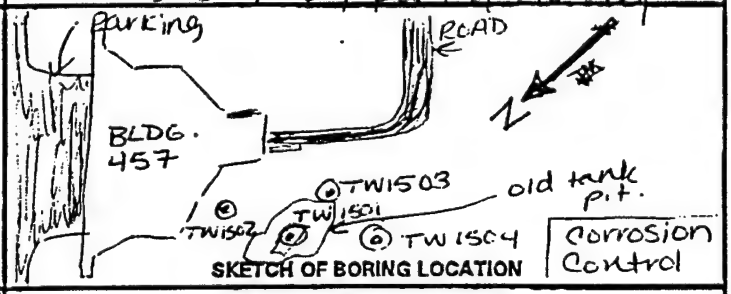
FIELD LOG OF BORING

WELL NO. TW1503

SHEET 1 OF 2

CORPORATION

PROJECT: EAKER AFB RFI	JOB NO.: 0114	BORING/WELL NO.: TW1503	
	LOGGED BY: G. Millar	TOTAL DEPTH OF BOREHOLE: 16'	
DRILLING CONTRACTOR: Tri-State Testing		SURFACE ELEV.:	DATUM:
DRILLER'S NAME: Mark Tothy		START TIME: 1730	DATE: 8/27/95
DRILL RIG TYPE: CME 55		FINISH TIME: 1900	DATE: 8/27/95
BORING METHOD: 7 1/4" HSA		WATER DEPTH:	
HOLE DIAMETER: 7 1/4"		DATE:	
SAMPLING METHOD: Continuous Sampling		TIME:	
HAMMER WGT.: NA	DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: Grassy		WEATHER: 80's-90's ; partly cloudy	



SKETCH OF BORING LOCATION

SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY	MATERIAL DESCRIPTION
0-5	CS w/ Liner	NA	5FT	3	0/0	Dry	Loose	10YR 4/4		1	SM	0.5' - 1.8' Sandy SILT, vfg angular well sorted qtz., some pea gravel, dk yellowish brn. (FILL).
										2		
										3		5.0' - 6.8' - Sandy SILT; grey w/ 10YR4/6 mottling dk yellowish brn.; trace clay (natural).
5										4		
5-8			3FT	2FT	0/0	Slt moist	Slt soft	10YR 6/1	EIS-SB-TW1503-6.5	5		6.8' - 12.0' silty SAND, vfg angular, well sorted qtz; slt sheen, strong fuel-like odor; dk greenish grey; more clay from 10.5' - 12.0'. Color changes at 10.5' to Grey w/ 10YR4/6 dk yellowish brn. mottling; appears laminated from 10.5 - 12.0'; some rootlets present.
					0/30	Wet SAT	Soft very Soft	Grey 5/GB		6		
8										7		
8-10	CS w/o Liner		2FT	2FT	30/30					8		
										9		
10					30/30					10		

6.8'

NOTES: To determine presence or absence of contamination.

EDITED BY/DATE:

Halliburton NUS CORPORATION

FIELD LOG OF BORING

WELL NO. TW1503

SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: TW1503

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.	
10.	CS WO liners	NA	5FT	5FT	3/12	SAT	Vry Soft	10YR 6/1		11		12.0' – 14.0' – Clayey SILT; Some vfg, well sorted, sand. Some rootlets; plastic; Grey.
					12/12	Vry moist	Soft			12		
					5/4			10YR 5/1		13	ML	14.0' – 15.0' – Silty CLAY, root casts + worm burrows filled with 5YR 4/6 yellowish red silty material. overall color Grey; Slt. plastic.
					4/4					14		
15					4/					15	CL	
15 1/2			1 FT	1 FT	0/					16		15.0' – 16.0' – logged by cuttings (same as 14.0' – 15.0' lithology).
												TD = 16'

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: Faker AFB

JOB NUMBER: 0114 | PROJECT MANAGER: Allan Jenkins

LOGGED BY: G. Millar | EDITED BY:

WELL NAME: TW1503 | DATE: 8/27/95

DRILLING COMPANY: Tri state Testing Services

EQUIPMENT: ☑ 7¼ INCH HOLLOW STEM AUGER | DRILLER: M. Totty

☐ _____ INCH ROTARY WASH | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: 5 GALLONS to hydrate

METHOD OF DECONTAMINATION PRIOR TO DRILLING: Steam Cleaning

DEVELOPMENT See Well Development Form

METHOD OF DEVELOPMENT:

DEVELOPMENT BEGAN DATE: TIME:

YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER _____

DEPTH TO WATER AFTER DEVELOPMENT: FEET

MATERIALS USED

5 1/16 SACKS OF 072495 GA OGNWELL Morie 20/40 Filtration media SAND

_____ SACKS OF _____ CEMENT

_____ GALLONS OF GROUT USED

_____ SACKS OF POWDERED BENTONITE

75 POUNDS OF BENTONITE PELLETS 1 1/2 buckets

10 FEET OF 2 INCH PVC BLANK CASING 1.5' cut off

10 FEET OF 2 INCH PVC SLOTTED SCREEN

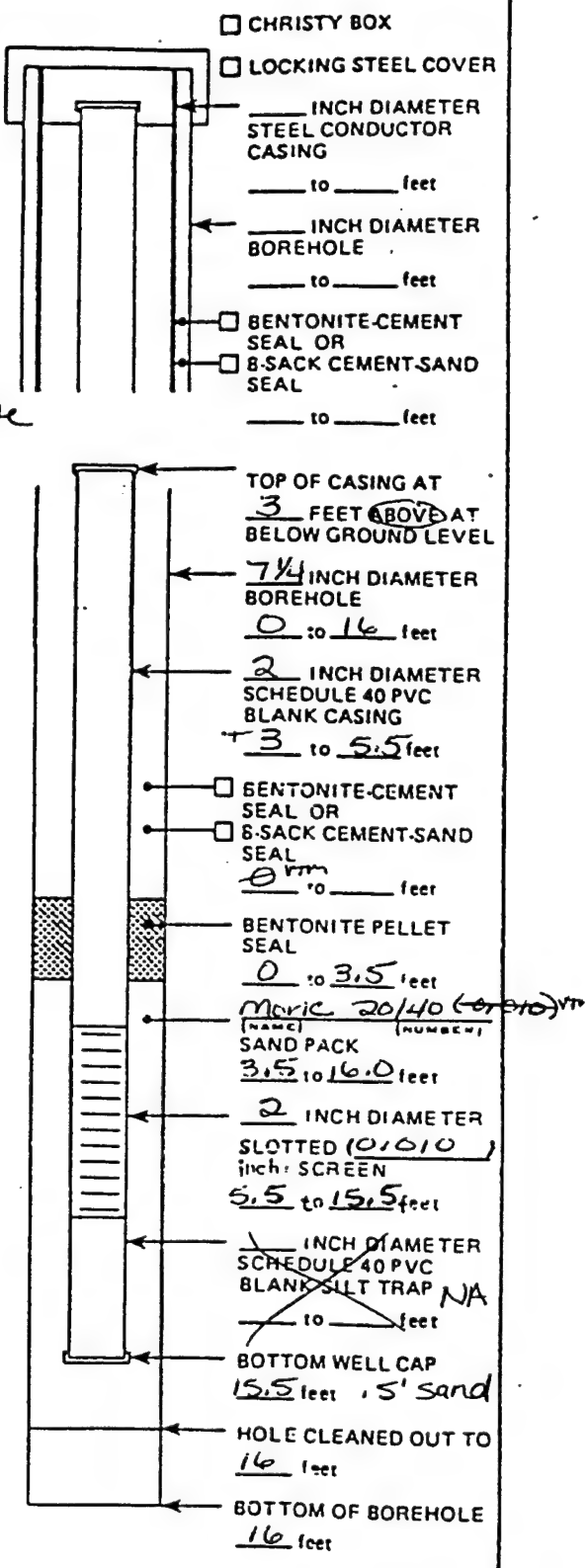
_____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

_____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☒ NO ☐ YES

NAME _____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☒ OTHER Temp Well



NOT TO SCALE

ADDITIONAL INFORMATION: _____

Calculated Sand = 6.12 sacks

Halliburton NUS

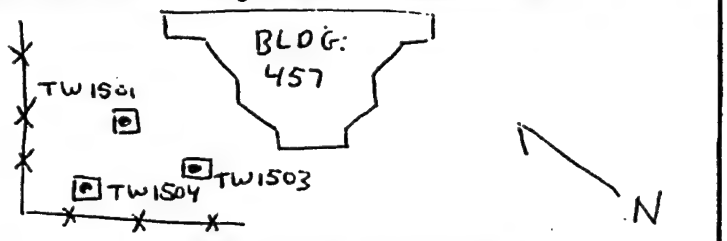
CORPORATION

FIELD LOG OF BORING

WELL NO. TW1504

SHEET 1 OF 2

PROJECT: EAKER AFB RFI	JOB NO.: 0114	BORING/WELL NO.:
	LOGGED BY: B. McCANLESS	TOTAL DEPTH OF BOREHOLE: 15.5'
DRILLING CONTRACTOR: Tri-State Testing	SURFACE ELEV.:	DATUM:
DRILLER'S NAME: MARK TOTTY	START TIME: 1428	DATE: 8/27/95
DRILL RIG TYPE: CME 55	FINISH TIME: 1517	DATE: 8/27/95
BORING METHOD: 7 1/4" HSA	WATER DEPTH:	
HOLE DIAMETER: 7 1/4"	DATE:	
SAMPLING METHOD: SPLIT BARREL W/LINERS	TIME:	
HAMMER WGT.: NA DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: VEGATATION	WEATHER: CLEAR, BREEZE, 90's	



SKETCH OF BORING LOCATION

SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY	MATERIAL DESCRIPTION
0	SB w/ liners	NA	5'	1.5'	0/0	DRY	loose	10YR 5/4		0	GC	0.5-3.5 FILL, silt matrix, roots, gravel & rock fragments yellowish brown
					0							
												3.5-8.5 sandy SILT, dark yellowish brown, sand vfg, not plastic
						MST	MED STF	10YR 4/4			ML	
5			3'	2'	0/0				EIS-SU-TW1504	5		
					0/0	WET	SOFT					
8						SAT						8.5-13 silty SAND, sand vfg, dk. yellowish brown, trace clay at 8 & 9.5', not plastic
8			2'	2'	0/0						ML	
10					0/0							

NOTES: DETERMINE PRESENCE OR ABSENCE OF CONTAMINATION

EDITED BY/DATE:

Halliburton NUS
CORPORATION

FIELD LOG OF BORING

WELL NO. TW1504
SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: TW1504

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.	
10	SB	NA	5'	4'	0/0	SAT	SOFT	10YR 4/4				
					0/0							
					0/0							13-15.5' silty CLAY, gray, trace sand, slightly plastic
					0/0	WET		10YR 5/1			OH	
15												TD - 15.5'

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: EAKER AFB

JOB NUMBER: 0114 | PROJECT MANAGER: ALLAN JENKINS

LOGGED BY: B. McCANLESS | EDITED BY:

WELL NAME: TW1504 | DATE: 8/27/95

DRILLING COMPANY: TRISTATE TESTING

EQUIPMENT: ☑ 7¼ INCH HOLLOW STEM AUGER | DRILLER: M. TUTTY

☐ _____ INCH ROTARY WASH | HOURS DRILLED:

GALLONS OF WATER USED DURING DRILLING: 8 GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: STEAM CLEAN

DEVELOPMENT

METHOD OF DEVELOPMENT: SEE DEVELOPMENT FORM

DEVELOPMENT BEGAN DATE: TIME:

YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER _____

DEPTH TO WATER AFTER DEVELOPMENT: FEET

MATERIALS USED

4 SACKS OF MORIE CO. FILTRATION MEDIA SAND

NA SACKS OF _____ CEMENT

NA GALLONS OF GROUT USED

NA SACKS OF POWDERED BENTONITE

75 POUNDS OF BENTONITE PELLETS 1.5 BUCKETS

10 FEET OF 2 INCH PVC BLANK CASING 1.5' CUTOFF

10 FEET OF 2 INCH PVC SLOTTED SCREEN

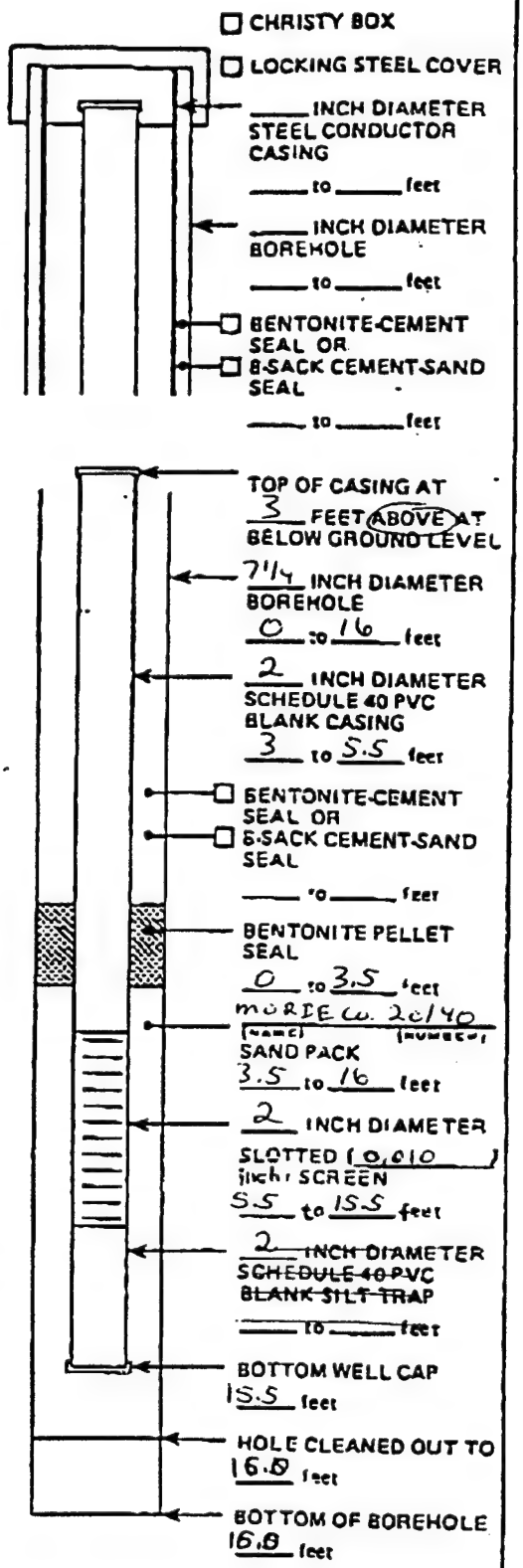
_____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

_____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☑ NO ☐ YES

NAME _____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☑ OTHER TEMPORARY WELL



NOT TO SCALE

ADDITIONAL INFORMATION: CALCULATED SAND= 6.25 BAGS

GEOLOGIC BORING LOG

JOB NUMBER.:	726876.68330	CLIENT:	AFCEE/Eaker AFB	DATE:	3/21/96
SITE:	UST 702	BORING DIA.:	2-inch	ELEVATION:	
BORING NUMBER:	702-SB1	CONTRACTOR:	Parsons ES	DATUM:	
RIG TYPE:	Geoprobe	WEATHER:	sl. cloudy, sl. breeze from north	GEOLOGIST:	D. Teets
TEMPERATURE (°F):	~50°F	DRLG MED:	Direct Push		
COMMENTS:					

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								Background soil sample in Baggy THVA = 90 ppmv 95 Hexane
1								
2								
3			3-5': Clay, silty, sandy, f, brn, v. moist, no staining or odor	X				
4				X				
5			5-7' SAA, except wet	X				e5' THVA = 240 ppmv
6				X				
7				X				e7' THVA = 100 ppmv
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.:	726876.68330	CLIENT:	AFCEE/Eaker AFB	DATE:	3/21/96
SITE:	UST 702	BORING DIA.:	2-inch	ELEVATION:	
BORING NUMBER:	702-SB2 (MPA-5.5)	CONTRACTOR:	Parsons ES	DATUM:	
RIG TYPE:	Geoprobe	WEATHER:		GEOLOGIST:	D. Teets
TEMPERATURE (°F):	~50°F	DRLG MED:	Direct Push		
COMMENTS:					

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								Background soil THVA = 90 ppmv as Hexane
1								
2								
3								
4			3-5': Clay, silty, brn, iron oxide staining, gray, no odor, moist					
5								5' THVA = 160 ppmv
6			DBT 5-7': 5-6.5: SAA except petroleum odor 6.5-7.0: SAA except wet					
7								7' THVA = 260 ppmv
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet
bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample
G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.:	726876.68330	CLIENT:	AFCEE/Eaker AFB	DATE:	3/21/96
SITE:	UST 702	BORING DIA.:	2-inch	ELEVATION:	
BORING NUMBER:	702-SB3	CONTRACTOR:	Parsons ES	DATUM:	
RIG TYPE:	Geoprobe	WEATHER:		GEOLOGIST:	D. Teets
TEMPERATURE (°F):	~50°F	DRLG MED:	Direct Push		
COMMENTS:					

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								Background Soil
1								THVA = 90 ppmv
								as Hexane
2								
3								
			3-5': Clay, silty, brn, sl gray, no odor, no staining, moist (BACKFILL?)					
4								
								@5' THVA = 40 ppmv
5								PID = 2.0/2.0
			5-7': SAA except wet					
6								
								@7' THVA = 90 ppmv
7								PID = 1.8/1.8
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.:	726876.68330	CLIENT:	AFCEE/Eaker AFB	DATE:	3/21/96
SITE:	UST 702	BORING DIA.:	2-inch	ELEVATION:	
BORING NUMBER:	702-SB4	CONTRACTOR:	Parsons ES	DATUM:	
RIG TYPE:	Geoprobe	WEATHER:		GEOLOGIST:	D. Teets
TEMPERATURE (°F):	~50°F	DRLG MED:	Direct Push		
COMMENTS:					

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								Background soil
1								THVA = 90 ppmv
								as Hexane
2								
3								
4								
			4-6': Clay, silty, brn/gray, v moist-wet, no odor					
5								
6								@ 6' THVA = 180 ppmv
								PID = 1.8/1.8
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.:	726876.68330	CLIENT:	AFCEE/Eaker AFB	DATE:	3/21/96
SITE:	UST 702	BORING DIA.:	2-inch	ELEVATION:	
BORING NUMBER:	702-SB5 (MPB-5)	CONTRACTOR:	Parsons ES	DATUM:	
RIG TYPE:	Geoprobe	WEATHER:		GEOLOGIST:	D. Teets
TEMPERATURE (°F):	~50°F	DRLG MED:	Direct Push		
COMMENTS:					

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								Background Soil
1								THVA = 90 ppmv
								as Hexane
2								
3								
4								
			4-5': Clay, silty, brn/gray, iron oxide	X				
5			staining, moist, petroleum odor	X				
			5-6': SAA wet, strong petroleum odor, more	X				
6			grossly contaminated at 5.5'-6.0';	X				@6' THVA = 260 ppmv
			Black tar at 6'	X				PID = 22/1.8
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.:	726876.68330	CLIENT:	AFCEE/Eaker AFB	DATE:	3/21/96
SITE:	UST 702	BORING DIA.:	2-inch	ELEVATION:	
BORING NUMBER:	702-SB6(MPC-4.5')	CONTRACTOR:	Parsons ES	DATUM:	
RIG TYPE:	Geoprobe	WEATHER:		GEOLOGIST:	D. Teets
TEMPERATURE (°F):	~50°F	DRLG MED:	Direct Push		
COMMENTS:					

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								Background soil
1								THVA = 90 ppmv
								as Hexane
2								
3								
4								
			4-5.5': Clay, silty, brn/gray, iron oxide	X				
5			staining, moist, petroleum odor	X				
			5.5-6': SAA except black staining, wet,	X				
6			strong petroleum odor	X				@6' THVA = 200 ppmv
								PID = 19.2/11.8
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.:	726876.68330	CLIENT:	AFCEE/Eaker AFB	DATE:	3/21/96
SITE:	UST 702	BORING DIA.:	2-inch	ELEVATION:	
BORING NUMBER:	702-SB7	CONTRACTOR:	Parsons ES	DATUM:	
RIG TYPE:	Geoprobe	WEATHER:		GEOLOGIST:	D. Teets
TEMPERATURE (°F):	~50°F	DRLG MED:	Direct Push		
COMMENTS:					

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								Background Soil
1								THVA = 90 ppmv
								as Hexane
2								
3								
4								
			4-5.5': Clay, silty, brn/gray, iron oxide					
5			staining, sl. blk staining, no odor, moist					
			5.5-6': SAA except wet					@ 6' THVA = 60 ppmv
6								PID = 1.8/1.4
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68330
SITE: UST 702
BORING NUMBER: 702-SB8
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~50°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/21/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
								Background soil THVA=100ppmv
1								
2								
3								
4			4-6': clay, v silty, brn/sl gray, moist, no odor	X				
5								@6': THVA=100ppmv PID=1.0/1.0
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet
bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample
G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68330
SITE: UST 702
BORING NUMBER: 702-SB9
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~50°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/21/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								Background soil THVA = 90 ppmv as Hexane
2								
3								
4			4-6'; Cl sy, v silty, brn/sl gray, moist, no odor					
5								@ 6' THVA = 70 ppmv PID = 1.5/1.2
6								
7								DBS
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68330
SITE: UST 702
BORING NUMBER: 702-SB10
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~50°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/21/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5			Clay, v silty, brn/sl gry, moist, no odor	X	No Samples			@6' THVA = 140ppmv PID = 15/1.4
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68230
SITE: UST 702 ~~Building 457 Area~~
BORING NUMBER: 702-SB11
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~50°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/21/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4								
5								
6								@6' THVA = 50 PID = 1.2/1.2
7								@8' THVA = 60 PID = 1.2/1.2
8								
9			No visible contamination @ SB11					
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

GEOLOGIC BORING LOG

JOB NUMBER.: 726876.68230
SITE: UST 702 ~~Building 457 Area~~
BORING NUMBER: 702-SB12
RIG TYPE: Geoprobe
TEMPERATURE (°F): ~50°F
COMMENTS:

CLIENT: AFCEE/Eaker AFB
BORING DIA.: 2-inch
CONTRACTOR: Parsons ES
WEATHER:
DRLG MED: Direct Push

DATE: 3/21/96
ELEVATION:
DATUM:
GEOLOGIST: D. Teets

Depth (ft.)	Pro-file	USCS	Geologic Description	Split Spoon Interval	Laboratory Sample Identification	Sample Type	PID ppmv	Remarks
1								
2								
3								
4			4-6 Backfill, Sand	X				
5								06' THA=50ppm
6								PID=1.2/1.2
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

PID - Photoionization Detector
BH - Borehole
SAA - Same As Above
Bkgrnd - Background
HSA - Hollow Stem Auger
ft - Feet

bgs - Below Ground Surface
na - Not Analyzed
ppmv - Parts per Million, Volume per Volume
HS - Sample Headspace
SS - Split Spoon Sample
BS - Brass Sleeve Sample

G - Grab Sample

Halliburton NUS

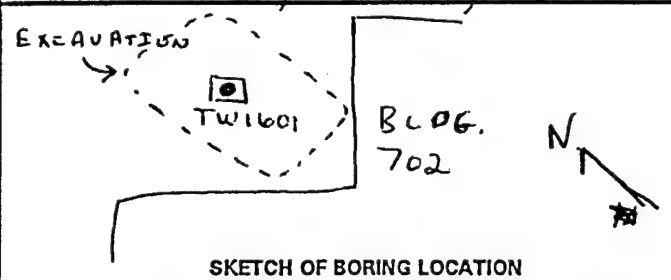
FIELD LOG OF BORING

WELL NO. TW1601

SHEET 1 OF 2

CORPORATION

PROJECT: EAKER AFB RFI (UST LOCATION)	JOB NO.: 0114	BORING/WELL NO.: TW1601
	LOGGED BY: B. MCCANLESS	TOTAL DEPTH OF BOREHOLE: 16'
DRILLING CONTRACTOR: Tri-State Testing	SURFACE ELEV.:	DATUM:
DRILLER'S NAME: JOE FLEEGER	START TIME: 0940	DATE: 9/12/95
DRILL RIG TYPE: CME 55	FINISH TIME: 1017	DATE: 9/12/95
BORING METHOD: 7 1/4" HSA	WATER DEPTH:	
HOLE DIAMETER: 7 1/4"	DATE:	
SAMPLING METHOD: SPLIT BARREL W/ + W/OUT LINER	TIME:	
HAMMER WGT.: NA DROP HGT: NA	BACKFILLED, TIME:	DATE:
SURFACE CONDITIONS: VEGATATION	WEATHER: CLEAR, BREEZE, 70's	



SKETCH OF BORING LOCATION

SAMPLE INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	INCHES RECOVERED	OVA READING (ppm)	MOISTURE	DENSITY	MUNSELL COLOR	LAB SAMPLE NUMBER	DEPTH IN FEET	LITHOLOGY	MATERIAL DESCRIPTION
0	SB w/ liner	NA	5'	3.5'	100/100	DRY	STF	10YR 5/4				0.5-5' SAND-silty SAND FILL, pea gravel to 1.5', yellowish brown, sand poorly sorted
					80/30	MST	SOFT					
					90/400							
					90/		loose		E16SS1-TW1601A	2		
5												
5			3'	1'	10/20	MST	SOFT	10YR 5/1			SM	5-8 silty SAND/sandy SILT, rootlets, sand is med grain
										▽		
8						SAT	loose					
8			2'	1.5'	10/20			10YR 3/1			SP	8-16 SAND, some silt, rootlets, charcoal pieces throughout angular to subrounded FUEL ODOR AT 10'
10					20/100							

NOTES: DETERMINE PRESENCE OR ABSENCE OF CONTAMINATION ⊗ 400 ppm AT 3' WAS 10 ppm W/FILTER

EDITED BY/DATE:

Halliburton NUS
CORPORATION

FIELD LOG OF BORING

WELL NO. TW1601
SHEET 2 OF 2

PROJECT: EAKER AFB RFI | JOB NO.: 0114 | BORING NO.: TW1601

INTERVAL	SAMPLE TYPE	BLOWS / 6-INCHES	INCHES DRIVEN	RECOVERY	OVA (ppm)	MOISTURE	DENSITY	COLOR	SAMPLE NUMBER	DEPTH IN FEET	LITH.	
10	SB	NA	5'	1.5'	50/60	SAT	loose				SP	SAND as from 8' qtz w/ chert angular to subrounded 2" DIA. CHARCOAL AT 11'
15												much charcoal 15-15.5'
16			1'	1'	10/30							TD=16'

NOTES: _____ EDITED BY/DATE: _____

Halliburton NUS CORPORATION

FIELD WELL COMPLETION FORM

JOB NAME: EAKER AFB

JOB NUMBER: 0114 | PROJECT MANAGER: A. JENKINS

LOGGED BY: B. McCANLESS | EDITED BY:

WELL NAME: TW1601 | DATE: 9/12/95

DRILLING COMPANY: TRI-STATE

EQUIPMENT: ☑ 7¼ INCH HOLLOW STEM AUGER ☐ ____ INCH ROTARY WASH | DRILLER: J. FLEEGER | HOURS DRILLED: 0.75

GALLONS OF WATER USED DURING DRILLING: 10 13 GALLONS

METHOD OF DECONTAMINATION PRIOR TO DRILLING: STEAM CLEAN

DEVELOPMENT

METHOD OF DEVELOPMENT: SEE DEVELOPMENT FORM

DEVELOPMENT BEGAN DATE: TIME:

YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:
YIELD: GPM	TIME: FROM	TO	DATE:

TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS

DESCRIPTION OF TURBIDITY AT END OF DEVELOPMENT: ☐ CLEAR ☐ SLIGHTLY CLOUDY ☐ MOD. TURBID ☐ VERY MUDDY

ODOR OF WATER:

WATER DISCHARGED TO: ☐ GROUND SURFACE ☐ TANK TRUCK ☐ STORM SEWERS ☐ STORAGE TANK ☐ DRUMS ☐ OTHER ____

DEPTH TO WATER AFTER DEVELOPMENT: FEET

MATERIALS USED

4 1/3 SACKS OF MORIE CO. FILTRATION OUN SAND

____ SACKS OF ____ CEMENT

____ GALLONS OF GROUT USED

____ SACKS OF POWDERED BENTONITE

62.5 POUNDS OF BENTONITE PELLETS 1¼ BUCKETS

10 FEET OF 2 INCH PVC BLANK CASING

10 FEET OF 2 INCH PVC SLOTTED SCREEN

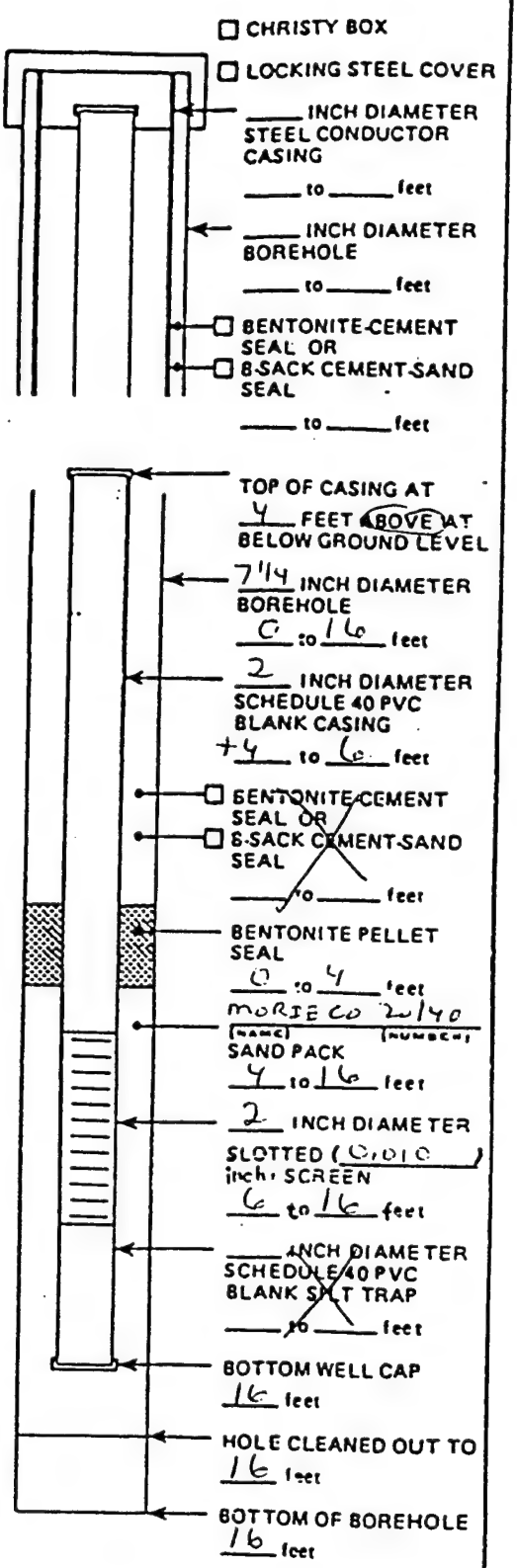
____ YARD³ CEMENT-SAND (REDI-MIX) ORDERED

____ YARD³ CEMENT-SAND (REDI-MIX) USED

CONCRETE PUMPER USED? ☑ NO ☐ YES

NAME ____

WELL COVER USED: ☐ LOCKING STEEL COVER ☐ CHRISTY BOX ☑ OTHER TEMP WELL



NOT TO SCALE

ADDITIONAL INFORMATION: SAND CHLC: 6 BAGS

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Parsons ES
ADDRESS 1700 Broadway Ste 900
CITY Denver STATE CO ZIP 80290
PHONE# (303)831-8100 FAX # (303)831-8208 FAX RESULTS (Y) / N

Sampler Name:
(signature) David Teets
(print) DAVID TEETS
Parsons
~~Evergreen~~ Analytical Cooler No. PES-1
Cooler Received

CLIENT CONTACT (print) DAVE TEETS
PROJECT I.D. 726876.68130
EAL. QUOTE # P.O.#
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ STD UST (3 day)
☐ Other (Specify)
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	PH, Alkalinity, iron, moisture, TKN, Phosphates, Cl, SO4 (circle)	EAL Sample No.
457-MPA-5-6.5	3/19/96	1000	1		X									X		X					
457-MPC-6-7	3/19/96	1500	1		X									X		X					
457-MPB-5-6	3/18/96	1543	1		X									X		X					
SS1-VW1-6.5-8	3/20/96	0840	1		X									X	X				X		
SS1-VW1-10-11	3/20/96	0930	1		X									X	X				X		
SS1-MPC-5.5-6.5	3/20/96	1400	1		X									X	X				X		
SS1-MPC-10-11	3/20/96	1430	1		X									X	X						
SS1-MPB-9-10	3/20/96	1115	1		X									X	X						
SS1-MPB-19-20	3/20/96	1130	1		X									X	X						
SS1-MPD-9-10	3/20/96	1550	1		X									X	X						
HT:																					Location
DD:																					Container Size

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

Instructions: For BTEX & TPH please sample from the "red" capped end preferentially.
Please FAX preliminary results ASAP

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
David Teets	3/25/96 1330	FED EX					

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Parsons ES
ADDRESS 1700 Broadway Ste 900
CITY Denver STATE CO ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 831-8208 FAX RESULTS (Y) / N

CLIENT CONTACT (print) DAVID TEETS
PROJECT I.D. 726876.68130
EAL. QUOTE # P.O.#
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ STD UST (3 day)
☐ Other (Specify)
*expedited turnaround subject to additional fee

Sampler Name:
(signature) David Teets
(print) DAVID TEETS
Parsons ~~Evergreen~~ Analytical Cooler No. DES-1
Cooler Received

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	PH, Alkalinity, iron, moisture, TEN, Phosphate, Soil Classification	EAL Sample No.
SS1-VW4-10-10.5	3/22/96	1230	1		X									X		X					
SS1-VW2-9-10	3/22/96	1630	1		X									X		X					
702-MPA-4-5	3/21/96	1000	1		X														X		
✓ 702-MPA-5.5-6	3/21/96	1020	1		X														X		
702-MPA-6.5-7	3/21/96	1020	1		X									X			X				
✓ 702-MPC-4-5	3/21/96	1340	1		X														X		
✓ 702-MPB-5.5-6	3/21/96	1315	1		X									X			X				
✓ 702-MPC-5.5-6	3/21/96	1340	1		X									X			X				
SS1-VW5-9.5-10.5	3/22/96	1630	1		X									X		X					
HT:																					Location
DD:																					Container Size

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

Instructions:

Relinquished by: (*Signature*)	Date/Time	Received by: (*Signature*)	Date/Time	Relinquished by: (*Signature*)	Date/Time	Received by: (*Signature*)	Date/Time
David Teets	3/25/96 1330	FEDEX					

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY PARSONS ES
ADDRESS 1700 Broadway Ste 900
CITY Denver STATE CO ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 831-8208 FAX RESULTS Y / N

CLIENT CONTACT (print) DAVID TEETS
PROJECT I.D. 726876.68230
EAL. QUOTE # P.O.#
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ STD UST (3 day)
☐ Other (Specify)
*expedited turnaround subject to additional fee

Sampler Name:
(signature) David Teets
(print) DAVID TEETS

Evergreen Analytical Cooler No.
Cooler Received

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	pH, alkalinity, iron, moisture, TEN, phosphates, soil classification	TKN only						EAL Sample No.
457-MPB-5-6	4/5/96	1315	1																X							
457-MPB-6-7	4/5/96	1315	1																X							
BG-2.5	4/5/96	1500	1																	X						
HT:																									Location	
DD:																									Container Size	

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

Instructions:

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
David Teets	4/5/96 1530	FED EX					

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

No 00863

Contact Person: DAVID TEETS
Company: PARSONS ES
Address: 1700 BROADWAY Ste 900 City: DENVER State: CO Zip: 80290
Phone: (303) 831-8100 FAX: (303)
Collected By: Signature: David Teets

Project info:
P.O. # 726876.68130
Project # SAA
Project Name: Eaker AFB
AFCEE Extended Bioventing

Turn Around Time:
☒ Normal
☐ Rush _____ Specify

Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt
	457-mPB-5	3/25/96 ~~1325~~ 1725	TO-3 (gas diesel)			
	457-mPC-4,5	3/25/96 1740				
	457-VW1	3/25/96 1900				
	SS1-mPD-9	3/27/96 1505	TO-3 (gas jet fuel)			
	SS1-VW2	3/27/96 1530				
	SS1-mPC-9	3/27/96 1541				
	SS1-mPB-8.5	3/27/96 1552				
	SS1-VW3	4/4/96 0900				
	SS1-mPA-9	4/4/96 0955				
	SS1-VW4	4/4/96 0940				

Relinquished By: (Signature) Date/Time: David Teets 4/4/96 1430
Print Name: David Teets
Relinquished By: (Signature) Date/Time: FED EX
Received By: (Signature) Date/Time
Relinquished By: (Signature) Date/Time
Received By: (Signature) Date/Time

Notes: No vacuum on canister # 94907.
Do not analyze canister # 9359 AT

Lab Use Only	Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact? Yes No None N/A	Work Order #

Form 1293 rev. 06

AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

N: 005530

CHAIN-OF-CUSTODY RECORD

Contact Person: DAVID TEETS
Company: PARSONS ES
Address: 1700 Broadway Ste 900 City: Denver State: CO Zip: 80290
Phone: (303) 831-8100 FAX: (303) 831-8208
Collected By: Signature: David Teets

Project info:
P.O.# 726876.68130
Project # SAA
Project Name: Eaker AFB

Turn Around Time:
☒ Normal
☐ Rush _____ Specify

Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt
	SS1-MW205 (VW6)	4/4/96 1020	TO-3 (as jet fuel)			
	SS1-MPE-9.5	4/4/96 1315	↓			
	702-MPB-5	4/1/96 1525	TO-3 (as Diesel)			

Relinquished By: (Signature) Date/Time: David Teets 4/4/96 1430 Print Name: David Teets
Relinquished By: (Signature) Date/Time: FEDEX Received By: (Signature) Date/Time:
Relinquished By: (Signature) Date/Time: Received By: (Signature) Date/Time:

Notes:

Lab Use Only	Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact? Yes No None N/A	Work Order #

Form 1293 rev. 06

Initial Respiration Test
Spill Site No. 1
Eaker AFB, AR

Monitoring Point	Date	Days Elapsed (frac. days)	Time	Hrs elapsed (fractional days)	Days Elapsed	Elapsed Time (min. x 1000)	Elapsed Time (hours)	O2%	CO2	Total Hydro-carbon	Helium (%)	Comments	Trend of O2/ Time	New x-values	k (%/minute)	k (%/hour)
MPA-9	03/29/96	0.00	09:28	0.00	0.00	0.00	0.00	19.8	0.07	50	7.4	30 sec. purge.	20.1963849	0	0.017974	1.078459
MPA-9	03/29/96	0.00	09:57	0.02	0.02	0.03	0.48	19.5	0.10	58	6.1		10.4902543	0.54		
MPA-9	03/29/96	0.00	11:10	0.07	0.07	0.10	1.70	18.3	0.07	86	6.7					
MPA-9	03/29/96	0.00	12:24	0.12	0.12	0.18	2.93	18.0	0.08	180	5.7					
MPA-9	03/29/96	0.00	14:40	0.22	0.22	0.31	5.20	14.5	0.10	400	5.4	Confirmed O2/CO2 calibration.				
MPA-9	03/29/96	0.00	18:25	0.37	0.37	0.54	8.95	10.3	0.15	980	5.6					
MPA-9	03/30/96	1.00	08:25	-0.04	0.96	1.38	22.95	3.8	0.50	5,200	3.9	30 sec. purge.				
MPB-8.5	03/29/96	0.00	09:26	0.00	0.00	0.00	0.00	20.0	0.05	140	5.9	30 sec. purge.	19.793609	0	0.018384	1.103011
MPB-8.5	03/29/96	0.00	09:55	0.02	0.02	0.03	0.48	19.3	0.07	220	6.1		9.86650645	0.54		
MPB-8.5	03/29/96	0.00	11:05	0.07	0.07	0.10	1.65	17.9	0.07	570	5.1					
MPB-8.5	03/29/96	0.00	12:22	0.12	0.12	0.18	2.93	16.3	0.08	730	5.8					
MPB-8.5	03/29/96	0.00	14:40	0.22	0.22	0.31	5.23	14.0	0.09	1,000	6.1	Confirmed O2/CO2 calibration.				
MPB-8.5	03/29/96	0.00	18:30	0.38	0.38	0.54	9.07	9.9	0.11	1,300	6.3					
MPB-8.5	03/30/96	1.00	08:30	-0.04	0.96	1.38	23.07	4.8	0.09	3,000	5.6	30 sec. purge.				
MPC-9	03/29/96	0.00	09:24	0.00	0.00	0.00	0.00	19.5	0.10	3,000	6.7	30 sec. purge.	20.222457	0	0.020787	1.247216
MPC-9	03/29/96	0.00	09:53	0.02	0.02	0.03	0.48	19.5	0.10	94	6.1		9.20538289	0.53		
MPC-9	03/29/96	0.00	11:00	0.07	0.07	0.10	1.60	18.7	0.08	200	5.7					
MPC-9	03/29/96	0.00	12:14	0.12	0.12	0.17	2.83	17.2	0.10	440	5.9					
MPC-9	03/29/96	0.00	14:35	0.22	0.22	0.31	5.18	14.0	0.20	1,800	5.2	Confirmed O2/CO2 calibration.				
MPC-9	03/29/96	0.00	18:15	0.37	0.37	0.53	8.85	8.8	0.30	7,800	5.1					
MPC-9	03/30/96	1.00	08:30	-0.04	0.96	1.39	23.10	1.6	1.50	5,200	3.5	30 sec. purge.				
MPD-9	03/29/96	0.00	09:20	0.00	0.00	0.00	0.00	20.8	0.05	96	NS		21.0030469	0	0.018512	1.110705
MPD-9	03/29/96	0.00	09:40	0.01	0.01	0.02	0.33	20.6	0.07	250	NS		11.1918175	0.53		
MPD-9	03/29/96	0.00	11:00	0.07	0.07	0.10	1.67	19.2	0.07	350	NS					
MPD-9	03/29/96	0.00	12:10	0.12	0.12	0.17	2.83	18.0	0.10	500	NS					
MPD-9	03/29/96	0.00	14:30	0.22	0.22	0.31	5.17	15.5	0.10	700	NS	Confirmed O2/CO2 calibration.				
MPD-9	03/29/96	0.00	18:10	0.37	0.37	0.53	8.83	11.0	0.20	1,200	NS					
MPD-9	03/30/96	1.00	08:40	-0.03	0.97	1.40	23.33	2.4	0.50	4,000	NS	30 sec. purge.				
VW-2	03/29/96	0.00	09:15	0.00	0.00	0.00	0.00	20.7	0.10	320	NS	2 min. purge.	20.7947117	0	0.016140	0.968413
VW-2	03/29/96	0.00	09:45	0.02	0.02	0.03	0.50	20.1	0.10	670	NS		11.9175879	0.55		
VW-2	03/29/96	0.00	11:15	0.08	0.08	0.12	2.00	19.3	0.10	1,250	NS					
VW-2	03/29/96	0.00	12:20	0.13	0.13	0.19	3.08	18.0	0.10	1,300	NS					
VW-2	03/29/96	0.00	14:35	0.22	0.22	0.32	5.33	15.2	0.12	1,700	NS	Confirmed O2/CO2 calibration.				
VW-2	03/29/96	0.00	18:20	0.38	0.38	0.55	9.08	12.1	0.25	2,400	NS					
VW-2	03/30/96	1.00	08:35	-0.03	0.97	1.40	23.33	5.0	0.60	8,200	NS	2 min. purge.				

Initial Respiration Test
BLDG 457
Eaker AFB, AR

Monitoring Point	Date	Days Elapsed (frac. days)	Time	Hrs elapsed (fractional days)	Days Elapsed	Elapsed Time (min. x 1000)	Elapsed Time (hours)	O2%	CO2	Total Hydro-carbon	Comments	Trend of O2/ Time	New x-values	k (%/minute)	k (%/hour)
MPB-5	03/27/96	0.00	08:10	0.00	0.00	0.00	0.00	20.8	0.10	90	30 sec. purge.	20.8878	0	0.052120	3.127200
MPB-5	03/27/96	0.00	08:40	0.02	0.02	0.03	0.50	19.5	0.10	38	30 sec. purge.	13.0698	0.15		
MPB-5	03/27/96	0.00	09:10	0.04	0.04	0.06	1.00	17.8	0.10	50	30 sec. purge.				
MPB-5	03/27/96	0.00	09:40	0.06	0.06	0.09	1.50	16.0	0.10	64	30 sec. purge.				
MPB-5	03/27/96	0.00	10:35	0.10	0.10	0.15	2.42	13.4	0.10	80	30 sec. purge.				
MPB-5	03/27/96	0.00	12:15	0.17	0.17	0.25	4.08	10.5	0.10	54	30 sec. purge, low battery HC meter.				
MPB-5	03/27/96	0.00	14:10	0.25	0.25	0.36	6.00	10.5	0.10	100	Recalibrated O2/CO2 meter at 1350. AC hookup on HC meter.				
MPB-5	03/27/96	0.00	18:40	0.44	0.44	0.63	10.50	3.5	0.20	160	30 sec. purge, dilution value HC.				
MPC-4.5	03/27/96	0.00	08:05	0.00	0.00	0.00	0.00	20.6	0.07	40	30 sec. purge.	20.1594595	0	0.057568	3.454054
MPC-4.5	03/27/96	0.00	08:35	0.02	0.02	0.03	0.50	18.8	0.10	36	30 sec. purge.	11.5243243	0.15		
MPC-4.5	03/27/96	0.00	09:05	0.04	0.04	0.06	1.00	16.0	0.08	47	30 sec. purge.				
MPC-4.5	03/27/96	0.00	09:35	0.06	0.06	0.09	1.50	14.2	0.09	42	30 sec. purge.				
MPC-4.5	03/27/96	0.00	10:35	0.10	0.10	0.15	2.50	12.2	0.08	54	30 sec. purge.				
MPC-4.5	03/27/96	0.00	12:15	0.17	0.17	0.25	4.17	6.3	0.10	30	30 sec. purge, low battery HC meter.				
MPC-4.5	03/27/96	0.00	14:05	0.25	0.25	0.36	6.00	7.0	0.08	67	Recalibrated O2/CO2 meter at 1350. AC hookup on HC meter.				
MPC-4.5	03/27/96	0.00	18:35	0.44	0.44	0.63	10.50	0.0	0.50	300	Used dilution value on HC meter.				
VW1	03/27/96	0.00	08:20	0.00	0.00	0.00	0.00	20.6	0.10	30	2 min. purge.	19.8428904	0	0.043170	2.590210
VW1	03/27/96	0.00	08:45	0.02	0.02	0.02	0.42	18.5	0.10	34	2 min. purge.	13.367366	0.15		
VW1	03/27/96	0.00	09:20	0.04	0.04	0.06	1.00	16.5	0.10	38	2 min. purge.				
VW1	03/27/96	0.00	09:50	0.06	0.06	0.09	1.50	15.7	0.10	44	2 min. purge.				
VW1	03/27/96	0.00	10:45	0.10	0.10	0.15	2.42	14.1	0.10	56	2 min. purge.				
VW1	03/27/96	0.00	12:25	0.17	0.17	0.25	4.08	13.3	0.12	10	2 min. purge. Low battery HC meter.				
VW1	03/27/96	0.00	14:15	0.25	0.25	0.36	5.92	14.3	0.10	44	2 min. purge.				
VW1	03/27/96	0.00	18:55	0.44	0.44	0.64	10.58	10.0	0.50	44	2 min. purge.				
MPA-5.5	03/27/96	0.00	08:15	0.00	0.00	0.00	0.00	20.5	0.10	38	30 sec. purge.	19.3742	0	0.050680	3.040800
MPA-5.5	03/27/96	0.00	08:45	0.02	0.02	0.03	0.50	17.2	0.10	35	30 sec. purge.	11.7722	0.15		
MPA-5.5	03/27/96	0.00	09:15	0.04	0.04	0.06	1.00	15.5	0.10	42	30 sec. purge.				
MPA-5.5	03/27/96	0.00	09:45	0.06	0.06	0.09	1.50	14.5	0.10	44	30 sec. purge.				
MPA-5.5	03/27/96	0.00	10:40	0.10	0.10	0.15	2.42	12.7	0.10	53	30 sec. purge.				
MPA-5.5	03/27/96	0.00	12:20	0.17	0.17	0.25	4.08	11.3	0.12	17	30 sec. purge, low battery HC meter.				
MPA-5.5	03/27/96	0.00	14:15	0.25	0.25	0.36	6.00	12.5	0.10	45	Recalibrated O2/CO2 meter at 1350. AC hookup on HC meter.				
MPA-5.5	03/27/96	0.00	18:50	0.44	0.44	0.64	10.58	8.2	0.40	NS	30 sec. purge.				

Initial Respiration Test
UST 702
Eaker AFB, AR

Monitoring Point	Date	Days Elapsed (frac. days)	Time	Hrs elapsed (fractional days)	Days Elapsed	Elapsed Time (min. x 1000)	Elapsed Time (hours)	O2%	CO2%	Total Hydro-carbon	Comments	Trend of O2/ Time	New x-values	k (%/minute)	k (%/hour)
VW	04/03/96	0.00	09:07	0.00	0.00	0.00	0.0	20.6	2.3	300	2 min. purge.	20.4810872	0	0.011099	0.665912
VW	04/03/96	0.00	09:33	0.02	0.02	0.03	0.4	20.0	4.0	NS	Monitored purge, water pulled after 80 sec.	19.7041903	0.07		
VW	04/03/96	0.00	10:15	0.05	0.05	0.07	1.1	19.8	4.8	NS	Monitored purge, water pulled after 90 sec.				
MPB-5	04/03/96	0.00	09:10	0.00	0.00	0.00	0.0	19.4	2.0	720	30 sec. purge, some water pulled.	19.1759119	0	0.009448	0.566893
MPB-5	04/03/96	0.00	09:27	0.01	0.01	0.02	0.3	19.0	1.8	560	30 sec. purge, some water pulled.	15.7745557	0.36		
MPB-5	04/03/96	0.00	09:55	0.03	0.03	0.05	0.8	18.9	1.9	720					
MPB-5	04/03/96	0.00	10:55	0.07	0.07	0.11	1.8	17.8	2.0	630	20 sec. purge, no water pulled.				
MPB-5	04/03/96	0.00	12:23	0.13	0.13	0.19	3.2	17.2	2.0	670	20 sec. purge, no water pulled.				
MPB-5	04/03/96	0.00	15:05	0.25	0.25	0.36	5.9	16.0	2.3	1,200	20 sec. purge, no water pulled.				
MPB-5	04/03/96	0.00	19:05	0.41	0.41	0.60	9.9	15.5	2.2	1,000	20 sec. purge, pulled very little water.				
MPB-5	04/04/96	1.00	08:10	-0.04	0.96	1.38	23.0	13.7	3.0	1,700	20 sec. purge, no water pulled.				
MPB-5	04/04/96	1.00	19:10	0.42	1.42	2.04	34.0	12.8	3.3	1,900	20 sec. purge, no water pulled.				

EAKER AFB - SPILL SITE NO. 1 - INITIAL

Biodegradation Rate Calculations

enter data | calculated data

Formula: $K_b = K_o \times 1/100\% \times A \times D_o \times C$ Where:

K_b = fuel biodegradation rate
K_o = O_2 utilization rate (%/min.)
A = volume of air/kg soil
D_o = O_2 density = 1340 mg/L
C = Carbon/O_2 ratio for hexane mineralization = 1/3.5

Solving for 1 L of soil:

Monitoring Point:		VW2		MPA-9	MPB-8.5	MPC-9	MPD-9
Oxygen util. rate	K_o =	0.01614	%/min.	0.01798	0.01838	0.02079	0.01851
Moisture content [a/]	w =	11.0	%	11.0	11.0	11.0	11.0
Soil Type [b/]		SILT,CLAY		SILT,CLAY	SILT,CLAY	SILT,CLAY	SILT,CLAY
Porosity:	n =	0.30		0.30	0.30	0.30	0.30
Unit weight (dry):	$^gd = G*^gw*(1-n)$ =	1.86	g/cm^3	1.86	1.86	1.86	1.86
Void ratio:	$e = n/1-n$ =	0.43		0.43	0.43	0.43	0.43
Specific gravity:	G =	2.65		2.65	2.65	2.65	2.65
Void volume:	$V_v = n * 1$ L =	0.3	liters	0.3	0.3	0.3	0.3
Deg. of saturation:	$S_r = Gw/e$ =	0.68		0.68	0.68	0.68	0.68
Volume of water:	$V_w = S_r * V_v$ =	0.2	liters	0.2	0.2	0.2	0.2
Volume of air:	$V_a = V_v - V_w$ =	0.10	liters	0.10	0.10	0.10	0.10
Bulk density:	$^gd + (V_w * ^gw)$ =	2.1	kg/L soil	2.1	2.1	2.1	2.1
Air filled volume:	A = V_a/Bulk Density	0.048	L air/kg soil	0.048	0.048	0.048	0.048
	K_b =	**1559**	mg TPH/ kg soil/ year	**1737**	**1775**	**2008**	**1788**

$K_b = K_o * 1/100\% * A * D_o * C *$ 525,600 min/yr

[a/] Moisture: For each monitoring point, the moisture value represents an average of three samples.

[b/] Assume: Soil properties are specified from Table 1.4. (Ref. Foundation Engineering, Peck, Hanson, and Thornburn, John Wiley Press, 1974)

EAKER AFB - BUILDING 457 AREA - INITIAL

Biodegradation Rate Calculations

enter data | calculated data

Formula: $K_b = K_o \times 1/100\% \times A \times D_o \times C$ Where:

K_b = fuel biodegradation rate
K_o = O_2 utilization rate (%/min.)
A = volume of air/kg soil
D_o = O_2 density = 1340 mg/L
C = Carbon/O_2 ratio for hexane mineralization = 1/3.5

Solving for 1 L of soil:

Monitoring Point:		VW1		MPA-5.5	MPB-5	MPC-4.5
Oxygen util. rate	K_o =	0.04317	%/min.	0.05068	0.05212	0.05757
Moisture content [a/]	*w* =	17.7	%	17.7	17.7	17.7
Soil Type [b/]		SILT,CLAY		SILT,CLAY	SILT,CLAY	SILT,CLAY
Porosity:	*n* =	0.34		0.34	0.34	0.34
Unit weight (dry):	$^{g}d = G*^{g}w*(1-n)$ =	1.75	g/cm^3	1.75	1.75	1.75
Void ratio:	*e* = *n*/1-*n* =	0.52		0.52	0.52	0.52
Specific gravity:	G =	2.65		2.65	2.65	2.65
Void volume:	$V_v = n * 1$ L =	0.34	liters	0.34	0.34	0.34
Deg. of saturation:	$S_r = Gw/e$ =	0.9		0.9	0.9	0.9
Volume of water:	$V_w = S_r * V_v$ =	0.31	liters	0.31	0.31	0.31
Volume of air:	$V_a = V_v - V_w$ =	0.03	liters	0.03	0.03	0.03
Bulk density:	$^{g}d + (V_w * ^{g}w)$ =	2.1	kg/L soil	2.1	2.1	2.1
Air filled volume:	A = V_a/Bulk Density	0.014	L air/kg soil	0.014	0.014	0.014
	K_b =	**1216**	mg TPH/ kg soil/ year	**1428**	**1468**	**1622**

$K_b = K_o * 1/100\% * A * D_o * C *$ 525,600 min/yr

[a/] Moisture: For each monitoring point, the moisture value represents an average of two samples.

[b/] Assume: Soil properties are specified from Table 1.4. (Ref. Foundation Engineering, Peck, Hanson, and Thornburn, John Wiley Press, 1974)

EAKER AFB - UST 702 - INITIAL

Biodegradation Rate Calculations

enter data	calculated data

Formula: $K_b = K_o \times 1/100\% \times A \times D_o \times C$ Where:

K_b = fuel biodegradation rate
K_o = O_2 utilization rate (%/min.)
A = volume of air/kg soil
D_o = O_2 density = 1340 mg/L
C = Carbon/O_2 ratio for hexane mineralization = 1/3.5

Solving for 1 L of soil:

Monitoring Point:		VW		MPB-5	
Oxygen util. rate	K_o =	0.01110	%/min.	0.00945	
Moisture content [a/]	w =	10.2	%	10.2	
Soil Type [b/]		SILT,CLAY		SILT,CLAY	
Porosity:	n =	0.30		0.30	
Unit weight (dry):	${}^{g}d = G*{}^{g}w*(1-n)$ =	1.86	g/cm^3	1.86	
Void ratio:	$e = n/1-n$ =	0.43		0.43	
Specific gravity:	G =	2.65		2.65	
Void volume:	$V_v = n * 1$ L =	0.3	liters	0.3	
Deg. of saturation:	$S_r = Gw/e$ =	0.63		0.63	
Volume of water:	$V_w = S_r * V_v$ =	0.19	liters	0.19	
Volume of air:	$V_a = V_v - V_w$ =	0.11	liters	0.11	
Bulk density:	${}^{g}d + (V_w * {}^{g}w)$ =	2.1	kg/L soil	2.1	
Air filled volume:	A = V_a/Bulk Density	0.052	L air/kg soil	0.052	
	K_b =	**1161**	mg TPH/ kg soil/ year	**989**	

$K_b = K_o * 1/100\% * A * D_o * C *$ 525,600 min/yr

[a/] Moisture: For each monitoring point, the moisture value represents an average of three samples.

[b/] Assume: Soil properties are specified from Table 1.4. (Ref. Foundation Engineering, Peck, Hanson, and Thornburn, John Wiley Press, 1974)

EAKER AFB - SPILL SITE 1

Steady-state Equation - Air Injection

Enter data

Calculated data

$$k = \frac{Q\,\mu\,\ln(Rw / Ri)}{H\,¾\,Patm\,[\,1 - (Pw / Patm)^2\,]}$$

Where:

Q = Volumetric flow rate of vent well

32.9	scfm x (30.48 cm/ft)^3 x (1 min/60 s) =	1.55E+04	cm^3/s
	μ = Viscosity of Air @ 18° C =	1.80E-04	g/cm s

Patm = Ambient pressure @ 250 feet of elevation (use Excel table to get this number)

402	inches H2O x (3.61E-2 psia/in. H2O) =	14.512	psia
14.512	psia x (6.89476E4 g/cm s²)/psia =	1.00E+06	g/cm s²

Rw = Radius of Vent Well

2	inches x 2.54 cm/in =	5.08	cm

H = Depth of Screen (length of screened interval)

10	feet x 30.48 cm/ft =	305	cm

Ri = Maximum Radius of Venting Influence

33	feet x 30.48 cm/ft =	1006	cm

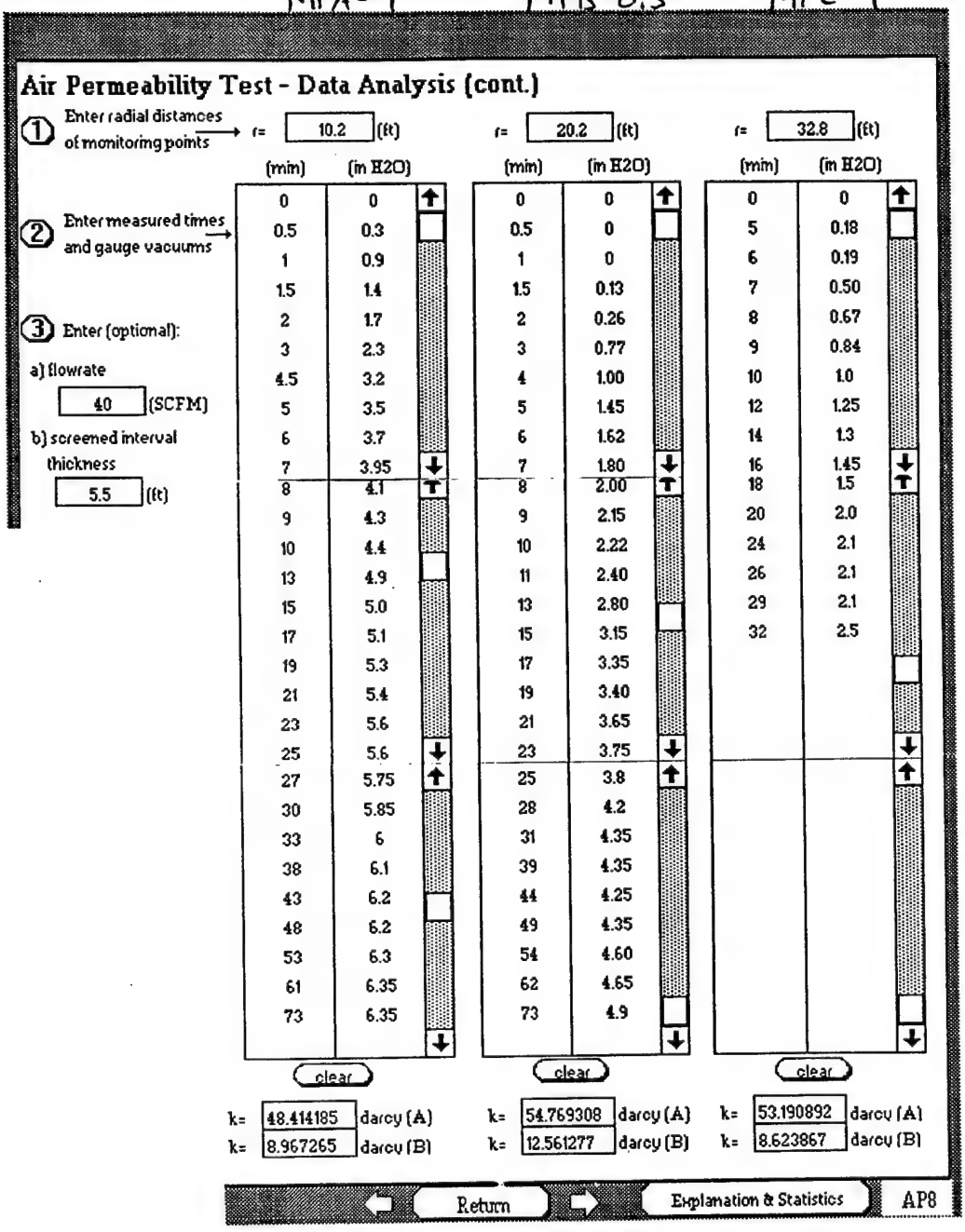
Pw = Absolute Pressure at Vent Well

41	inches H2O x (3.61E-2 psia/in. H2O) =			1.480	psia
1.480	psia +	14.512	psia =	15.992	psia
15.992	psia x (6.89476E4 g/cm s²)/psia =			1.10E+06	g/cm s²

	k =	7.196E-08	cm²
7.200E-08	cm² x (1 m/100 cm)² =	7.200E-12	m²
7.200E-12	m² x 1 darcy/(9.870E-13 m²) =	7.29	darcys

Eaker AFB
Spill Site No. 1

MPA-9 MPB-8.5 MPC-9



EAKER AFB - Bldg 457 Area

Steady-state Equation - Air Injection

Enter data

Calculated data

$$k = \frac{Q\,\mu\,\ln(Rw / Ri)}{H\,¾\,Patm\,[\,1 - (Pw / Patm)^2\,]}$$

Where:

Q = Volumetric flow rate of vent well

11.5	scfm x (30.48 cm/ft)^3 x (1 min/60 s) =	5.43E+03	cm^3/s
	μ = Viscosity of Air @ 18° C =	1.80E-04	g/cm s

Patm = Ambient pressure @ 250 feet of elevation (use Excel table to get this number)

402	inches H2O x (3.61E-2 psia/in. H2O) =	14.512	psia
14.512	psia x (6.89476E4 g/cm s²)/psia =	1.00E+06	g/cm s²

Rw = Radius of Vent Well

1	inches x 2.54 cm/in =	2.54	cm

H = Depth of Screen (length of exposed screened interval)

5.5	feet x 30.48 cm/ft =	168	cm

Ri = Maximum Radius of Venting Influence

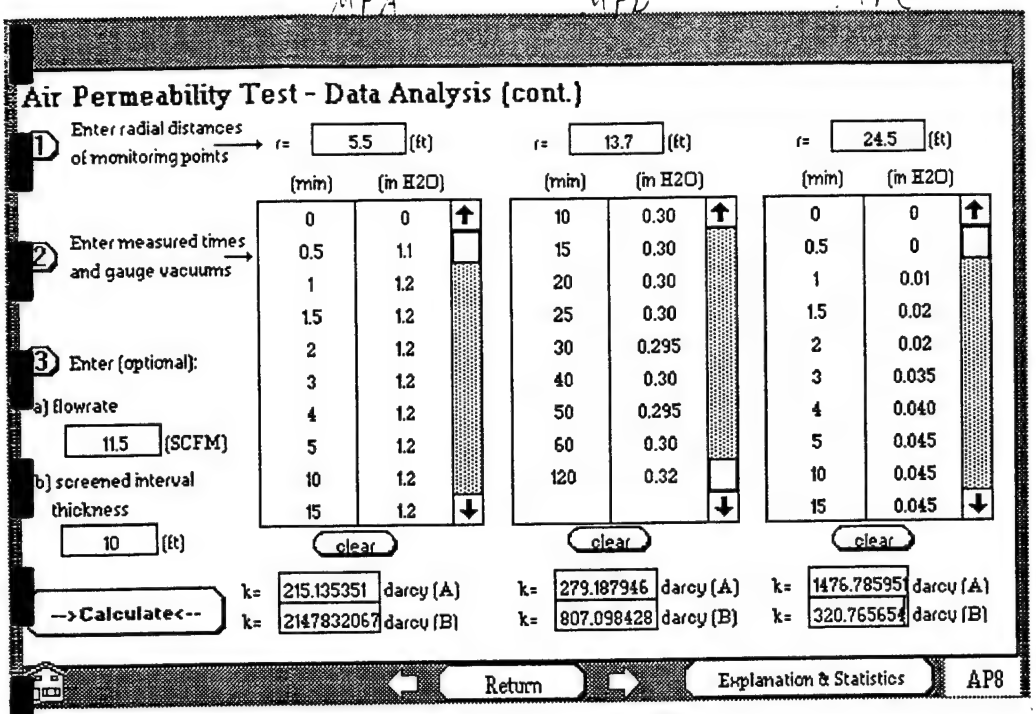
25	feet x 30.48 cm/ft =	762	cm

Pw = Absolute Pressure at Vent Well

26	inches H2O x (3.61E-2 psia/in. H2O) =			0.939	psia
0.939	psia +	14.512	psia =	15.451	psia
15.451	psia x (6.89476E4 g/cm s²)/psia =			1.07E+06	g/cm s²

	k =	7.918E-08	cm²
7.920E-08	cm² x (1 m/100 cm)² =	7.900E-12	m²
7.900E-12	m² x 1 darcy/(9.870E-13 m²) =	8	darcys

MPA MFD MPC



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B/457 Area
4/2/96

EAKER AFB - UST 702

Steady-state Equation - Air Injection

Enter data

Calculated data

$$k = \frac{Q\,\mu\,\ln(Rw / Ri)}{H\,¾\,Patm\,[\,1 - (Pw / Patm)^2\,]}$$

Where:

Q = Volumetric flow rate of vent well

11.1	scfm x (30.48 cm/ft)^3 x (1 min/60 s) =	5.24E+03	cm^3/s
	μ = Viscosity of Air @ 18° C =	1.80E-04	g/cm s

Patm = Ambient pressure @ 250 feet of elevation (use Excel table to get this number)

402	inches H2O x (3.61E-2 psia/in. H2O) =	14.512	psia
14.512	psia x (6.89476E4 g/cm s²)/psia =	1.00E+06	g/cm s²

Rw = Radius of Vent Well

1	inches x 2.54 cm/in =	2.54	cm

H = Depth of Screen (length of exposed screened interval)

3	feet x 30.48 cm/ft =	91	cm

Ri = Maximum Radius of Venting Influence

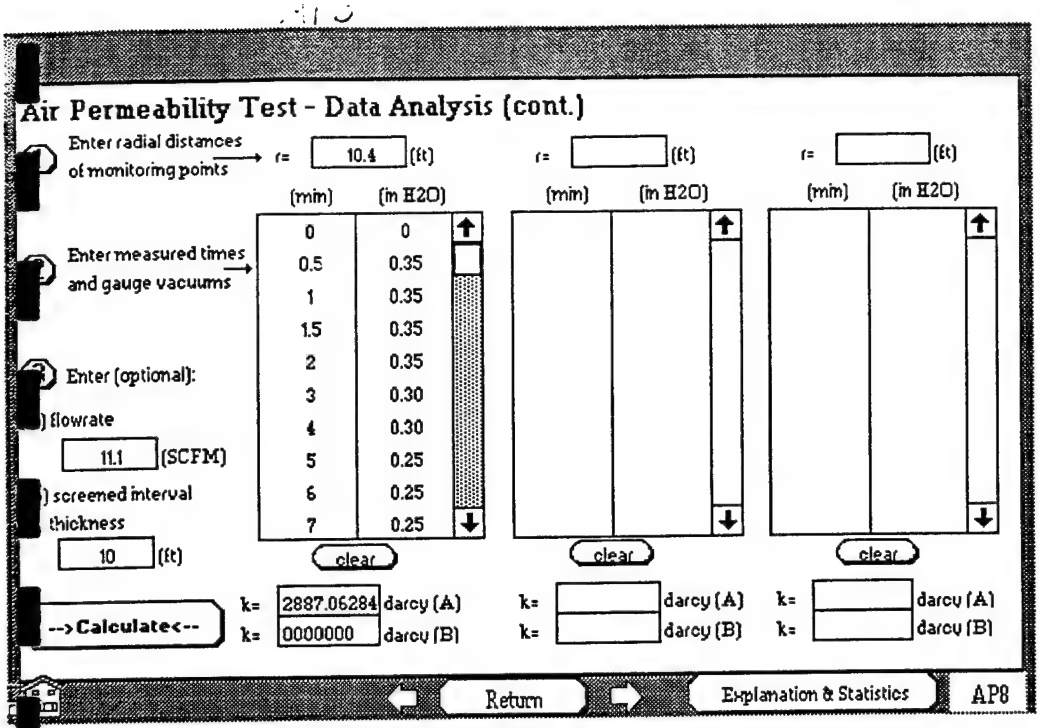
20	feet x 30.48 cm/ft =	610	cm

Pw = Absolute Pressure at Vent Well

35	inches H2O x (3.61E-2 psia/in. H2O) =			1.264	psia
1.264	psia +	14.512	psia =	15.776	psia
15.776	psia x (6.89476E4 g/cm s²)/psia =			1.09E+06	g/cm s²

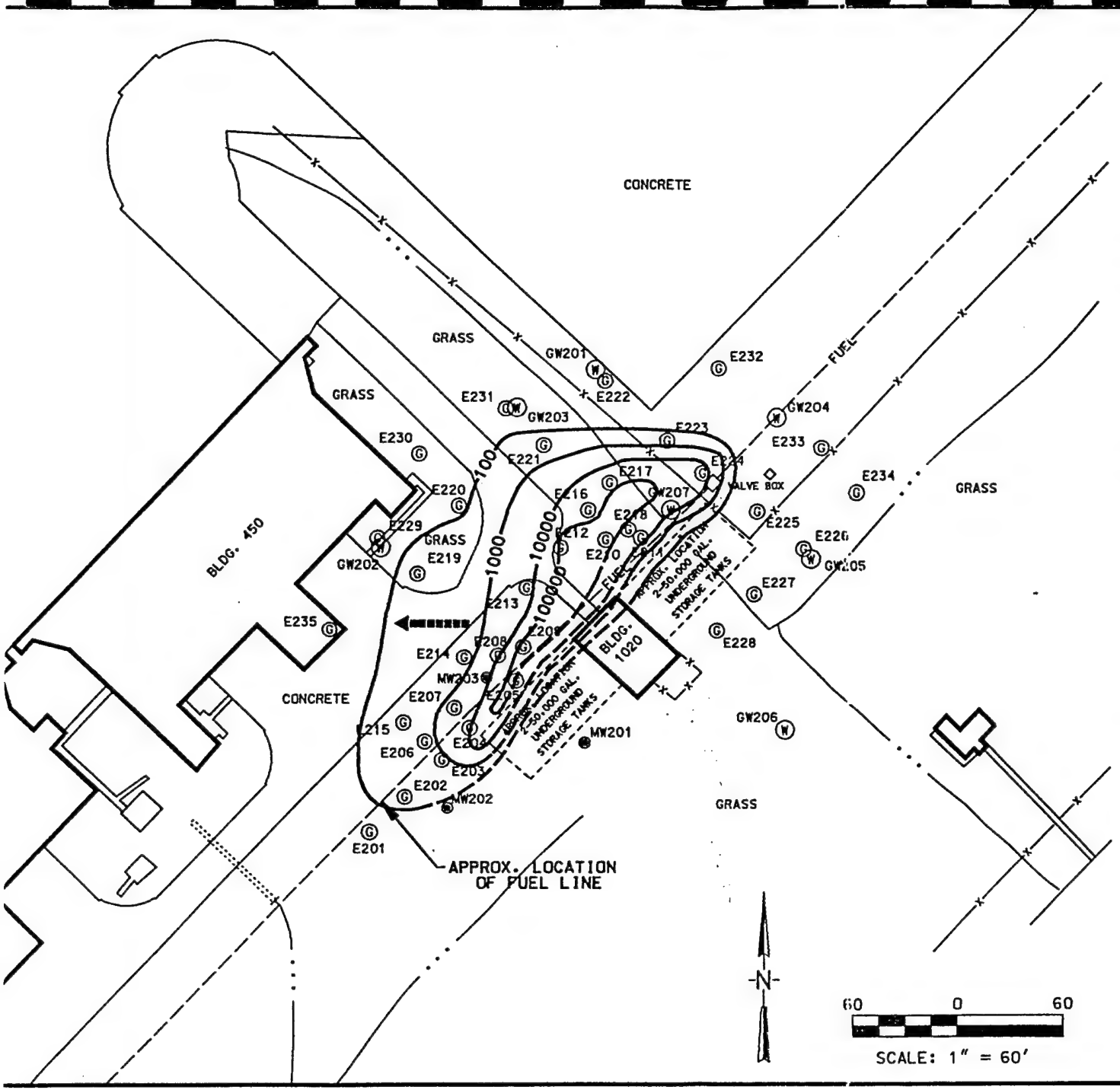
	k =	9.897E-08	cm²
9.900E-08	cm² x (1 m/100 cm)² =	9.900E-12	m²
9.900E-12	m² x 1 darcy/(9.870E-13 m²) =	10.03	darcys

Eaker
UST 702
4/2/96



APPENDIX B

SOIL GAS SURVEY SUMMARY



LEGEND

MONITORING WELL	MW201
SOIL GAS SAMPLING POINT	SG201
GROUNDWATER SCREENING SAMPLE	GW201
GROUNDWATER FLOW DIRECTION	
TOTAL VOCs[1] ISOCONCENTRATION LINE (DASHED WHERE APPROX.)	
FENCE	
SURFACE DRAINAGE	

SAMPLE NO.	TOTAL VOCs[1] (FID)	SAMPLE NO.	TOTAL VOCs[1] (FID)
E201	24	E219	253
E202	130	E220	71
E203	750	E221	219
E204	95770	E222	2.8
E205	84920	E223	262
E206	817	E224	14620
E207	2282	E225	2.8
E208	14710	E226	<1
E209	157900	E227	<1
E210	166200	E228	<1
E211	63990	E229	<1
E212	200900	E230	18
E213	5772	E231	<1
E214	339	E232	<1
E215	165	E233	<1
E216	87020	E234	<1
E217	95150	E235	5.5
E218	92710		

1 - CONCENTRATIONS IN $\mu g/L$ OF AIR

SOURCE:

TECHNICAL MEMORANDUM (STEP 2) FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY HNUS, 1992 (REVISED)

FIGURE 4-8

TITLE
TOTAL VOLATILE ORGANIC COMPOUNDS DETECTED IN SOIL GAS DESCRIPTION OF CURRENT CONDITIONS
SPILL SITE No. 1
EAKER AIR FORCE BASE

DRAWING NO.	DATE
0114G005	12-29-93

SOIL GAS SURVEY

BAKER AIR FORCE BASE

BLYTHEVILLE, ARKANSAS

PREPARED FOR

HALLIBURTON NUS ENVIRONMENTAL CORPORATION

JACKSON PLAZA, C-200

800 OAK RIDGE TURNPIKE

OAK RIDGE, TENNESSEE 37830

PREPARED BY

TARGET ENVIRONMENTAL SERVICES, INC.

9180 RUMSEY ROAD

COLUMBIA, MARYLAND 21045

(301) 992-6622

JANUARY 1992

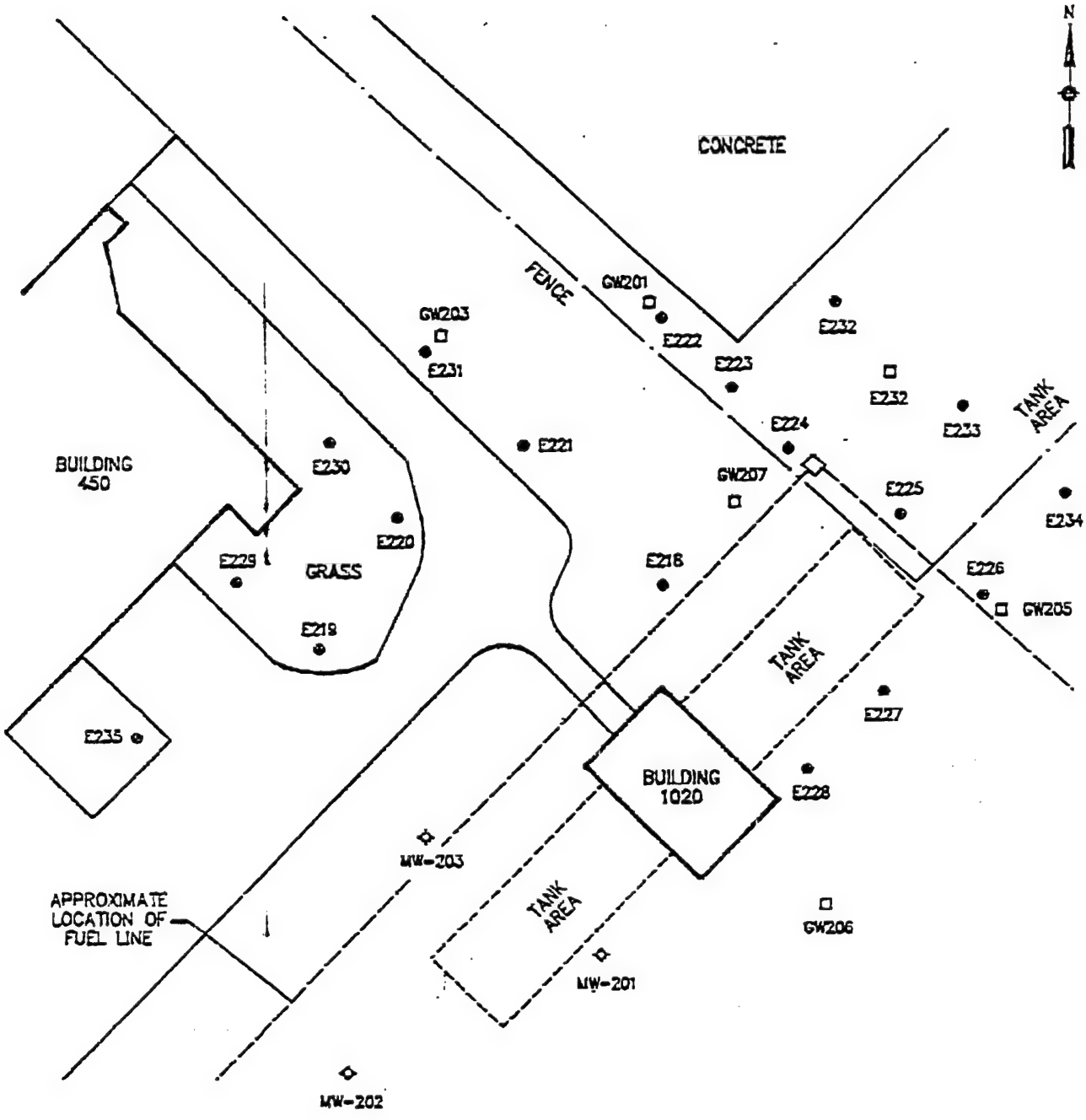


FIGURE 2. Sample Locations

TARGET ENVIRONMENTAL SERVICES, INC.

SPILL SITE #1
REMEDIAL INVESTIGATION REPORT
EAKER AIR FORCE BASE
BLYTHEVILLE, ARKANSAS

This map is integral to a written report and should be viewed in that context.

Field Procedures

Soil gas samples were collected at a total of 63 locations at the site. Proposed Sample E101 was not collected due to the presence of water. To collect the samples, a van-mounted hydraulic probe was used to advance connected 3 foot sections of 1 inch diameter threaded steel casing down to the sampling depth. Because of limited soil vapor in the very tight and moist clay soils, the probe was advanced to a depth of 8 to 9 feet and then drawn up to approximately 6 feet in order to obtain sufficient vapor for a sample at several locations. Sample E315 was collected at a depth of 5 feet from a 6 foot hole. The entire sampling system was purged with ambient air drawn through an organic vapor filter cartridge. A teflon line was inserted into the casing to the bottom of the hole, and the bottom-hole line perforations were isolated from the up-hole annulus by an inflatable packer. A sample of in-situ soil gas was then withdrawn through the probe and used to purge atmospheric air from the sampling system. A second sample of soil gas was withdrawn through the probe and encapsulated in a pre-evacuated glass vial at two atmospheres of pressure (15 psig). The self-sealing vial was detached from the sampling system, packaged, labeled, and stored for laboratory analysis.

Prior to the day's field activities all sampling equipment and probes were decontaminated by washing with soapy water and rinsing thoroughly. Internal surfaces were flushed dry using pre-purified nitrogen or filtered ambient air, and external surfaces were wiped clean using clean paper towels.

Field control samples were collected at the beginning and end of each day's field activities and after completion of sampling in each area. These QA/QC samples were obtained by filtering ambient air through a dust and organic vapor filter cartridge and collecting in the same manner as described above.

Laboratory Procedures

All of the samples collected during the field phase of the survey were analyzed according to EPA Method 602 (modified) on a gas chromatograph equipped with a flame ionization detector (GC/FID), but using direct injection instead of purge and trap. Analytes selected for standardization were:

benzene
toluene
ethylbenzene
meta- and para- xylene
ortho-xylene

These compounds were chosen because of their utility in evaluating the presence of petroleum products such as fuels, lubricating oils, and non-halogenated solvents.

Samples E501-E520, from the waste oil UST area, were also analyzed according to EPA Method 601 on a gas chromatograph equipped with an electron capture detector (ECD), but using direct injection instead of purge and trap. Specific analytes standardized for the ECD analysis were:

1,1-dichloroethene (11DCE)
methylene chloride (CH_2Cl_2)
trans-1,2-dichloroethene (t12DCE)
chloroform ($CHCl_3$)
1,1-dichloroethane (11DCA)
carbon tetrachloride (CCl_4)
cis-1,2-dichloroethene (c12DCE)
1,1,1-trichloroethane (111TCA)
trichloroethene (TCE)
1,1,2-trichloroethane (112TCA)
tetrachloroethene (PCE)

The chlorinated hydrocarbons in this suite were chosen because of their common usage in industrial solvents, and/or their degradational relationship to commonly used compounds.

The analytical equipment was calibrated using an instrument-response curve and injection of known concentrations of the above standards. Retention times of the standards were used to identify the peaks in the chromatograms of the field samples, and their response factors were used to calculate the analyte concentrations.

Total FID Volatiles values were generated by summing the areas of all integrated chromatogram peaks and calculated using the instrument response factor for toluene. Injection peaks, which also contain the light hydrocarbon methane, were excluded to avoid the skewing of Total FID Volatiles values due to injection disturbances and biogenic methane. For samples with low hydrocarbon concentrations, the calculated Total FID Volatiles concentration is occasionally lower than the sum of the individual analytes. This is because the response factor used for the Total FID Volatiles calculation is a constant, whereas the individual analyte response factors vary with concentration. It is important to understand that the Total FID Volatiles levels reported are relative, not absolute, values.

The tabulated results of the laboratory analysis of the soil gas samples are reported in micrograms per liter (µg/l) in Tables 1 and 2. Although "micrograms per liter" is equivalent to "parts per billion (v/v)" in water analyses, they are not equivalent in gas analyses, due to the difference in the mass of equal volumes of water and gas matrices. The xylenes concentrations reported in Table 1 are the sum of the m- and p-xylene and o-xylene concentrations for each sample.

For QA/QC purposes, a duplicate analysis was performed on every tenth field sample. Laboratory blanks of carrier gas were also analyzed after every tenth field sample.

TABLE 1

ANALYTE CONCENTRATIONS VIA GC/FID (ug/L)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID VOLATILES[1]
E201	1.6	<1.0	<1.0	1.8	24
E202	4.8	<1.0	1.4	4.1	130
E203	7.3	<1.0	10	12	750
E204	515	54	327	638	95,770
E205	912	62	142	612	84,920
E206	3.4	<1.0	5.5	25	817
E207	12	1.1	20	33	2,282
E208	242	41	64	158	14,710
E209	3,063	59	261	597	157,900
E210	1,245	47	292	706	166,200
E211	785	48	481	547	83,990
E212	2,734	435	226	635	200,900
E213	117	141	76	270	5,772
E214	5.9	2.4	4.2	13	339
E215	1.7	<1.0	1.9	4.4	165
E216	650	43	364	741	87,020
E217	552	63	143	352	95,150
E301	70	<1.0	49	135	2,243
E302	106	1.5	54	120	2,812
E303	88	1.9	75	191	2,635
E304	318	13	184	510	11,470
E305	164	24	149	353	16,810
E306	<1.0	<1.0	<1.0	4.7	182
E307	39	<1.0	22	94	1,380
E308	29	<1.0	28	69	1,000
E309	7.4	20	60	107	4,458
E310	87	3.3	62	204	3,290
E311	68	<1.0	57	190	1,912
E312	99	<1.0	60	201	2,336
E313	144	7.9	125	542	9,371
E314	101	20	312	712	22,640
E315	23	<1.0	28	132	2,283
E316	116	1.6	76	325	4,205
E317	1.6	<1.0	1.0	<1.0	68
E318	58	1.6	89	321	2,818
E319	127	3.2	108	395	5,302
E320	1,547	103	509	1,582	89,980
E321	195	9.1	113	507	12,300
E322	98	<1.0	55	114	2,288
E323	43	47	48	298	3,821
E324	273	44	251	1,132	35,030
E325	4.4	<1.0	4.5	15	148
E326	<1.0	<1.0	<1.0	<1.0	6.4
E501	94	22	210	551	17,740
E502	24	9.7	134	332	8,131
E503	82	167	77	134	28,560
E504	17	8.2	41	73	9,213
E505	3.9	<1.0	13	49	757
E506	98	8.7	147	351	7,608
E507	115	8.9	134	310	10,960
E508	153	5.3	88	208	9,408
E509	252	37	294	560	41,990
E510	1,156	110	425	707	168,800
E511	4.1	1.0	11	16	635
E512	<1.0	<1.0	<1.0	2.5	7.5
E513	33	63	150	1,055	14,890
E514	1.1	1.3	4.3	22	508
E515	51	4.4	80	125	4,954
E516	474	116	576	426	99,610
E517	<1.0	<1.0	9.5	11	331

[1]CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

TABLE 1 (cont.)

ANALYTE CONCENTRATIONS VIA GC/FID (ug/l)

SAMPLE	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID VOLATILES[1]
E518	<1.0	1.6	35	65	1,105
E519	8.2	3.0	25	43	2,017
E520	<1.0	<1.0	1.1	2.1	31
FIELD CONTROL SAMPLES					
E231	<1.0	<1.0	<1.0	2.2	9.4
E232	<1.0	<1.0	<1.0	<1.0	<1.0
E331	<1.0	<1.0	<1.0	<1.0	<1.0
E332	<1.0	<1.0	<1.0	<1.0	<1.0
E333	<1.0	<1.0	<1.0	<1.0	<1.0
E334	<1.0	<1.0	<1.0	<1.0	<1.0
E531	<1.0	<1.0	<1.0	<1.0	<1.0
E532	<1.0	<1.0	1.1	2.5	17
E533	<1.0	<1.0	<1.0	<1.0	<1.0
E534	<1.0	<1.0	<1.0	<1.0	<1.0
LABORATORY DUPLICATE ANALYSES					
E210	1,245	47	292	706	166,200
E210R	1,230	41	282	680	158,400
E308	29	<1.0	28	69	1,000
E308R	29	<1.0	27	66	974
E318	58	1.6	89	321	2,818
E318R	58	1.6	90	313	2,806
E332	<1.0	<1.0	<1.0	<1.0	<1.0
E332R	<1.0	<1.0	<1.0	<1.0	<1.0
E508	153	5.3	88	208	9,408
E508R	151	5.2	85	201	9,330
E518	<1.0	1.6	35	65	1,105
E518R	<1.0	1.4	31	58	985
LABORATORY BLANKS					
BSNUE-1	<1.0	<1.0	<1.0	<1.0	<1.0
BSNUE-2	<1.0	<1.0	<1.0	<1.0	<1.0
BSNUE-3	<1.0	<1.0	<1.0	<1.0	<1.0
BSNUE-4	<1.0	<1.0	<1.0	<1.0	<1.0
BSNUE-5	<1.0	<1.0	<1.0	<1.0	<1.0
BSNUE-6	<1.0	<1.0	<1.0	<1.0	<1.0

[1]CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

TABLE 2

ANALYTE CONCENTRATIONS VIA GC/ECD (µg/l)

SAMPLE	11DCE	CH_2Cl_2	t12DCE	11DCA	c12DCE	$CHCl_3$	111TCA	CCl_4	TCE	112TCA	PCE
E501	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E502	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E503	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E504	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E505	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E506	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E507	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E508	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E509	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	0.07
E510	<1.0	<1.0	<1.0	<1.0	14	<0.10	<0.10	<0.05	<0.10	<0.10	0.15
E511	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E512	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E513	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E514	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E515	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E516	<1.0	<1.0	<1.0	<1.0	11	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E517	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E518	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E519	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E520	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
FIELD CONTROL SAMPLES											
E531	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E532	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E533	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E534	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
LABORATORY DUPLICATE ANALYSES											
E508	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E508R	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E518	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
E518R	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
LABORATORY BLANKS											
BSNUE-1	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05
BSNUE-2	<1.0	<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.05	<0.10	<0.10	<0.05

11DCE	=	1,1-dichloroethene	CH_2Cl_2	=	methylene chloride
t12DCE	=	trans-1,2-dichloroethene	11DCA	=	1,1-dichloroethane
c12DCE	=	cis-1,2-dichloroethene	$CHCl_3$	=	chloroform
111TCA	=	1,1,1-trichloroethane	CCl_4	=	carbon tetrachloride
TCE	=	trichloroethene	112TCA	=	1,1,2-trichloroethane
PCE	=	tetrachloroethene			

TABLE 4-8
ANALYTES DETECTED IN GROUNDWATER -
SPILL SITE NO. 5
(PAGE TWO)

Sample Location	MW202			MW203		
Sample Number	BL02-GW-MW202A	E02-GW-MW202B	E02-GW-MW202C	BL02-GW-MW203A	E02-GW-MW203B	E02-GW-MW203C
Date Sampled	6/8/88	7/17/91	12/14/91	6/9/88	7/17/91	12/14/91
VOCs (ug/L)						
Acetone			280J			
2-Butanone			20			
Toluene						
Benzene				1500	210	680
Ethylbenzene				550	15	21
Total Xylenes				1210		13
Total BTEX				3260	225	714
TPH (mg/L)				5.9		0.7
Total Dissolved Solids (mg/L)	NA	324	310 J	NA	504	560

Footnotes:
VOCs - Volatile Organic Compounds
Total BTEX - Sum total of Benzene, Toluene, Ethylbenzene, and Total Xylene concentrations
TPH - Total Petroleum Hydrocarbons
J - Concentration is estimated
Blank Space - Compound not detected above method quantitation limit
NA - Compound not analyzed
D qualifier in Sample Number - Duplicate sample

Note: 1.) Only compounds detected at or above method quantitation limits are presented on groundwater tables; a list of all analyzed compounds their quantitation limits, and their analytical methos references may be found in Appendix L.

2.) Analytical Methods:
VOCs - 1988 samples - EPA CLP, 1987b; 1991 samples EPA CLP, 1988a
TPHs - EPA 418.1 for both 1988 and 1991 samples

APPENDIX C
O&M CHECKLIST

DATA COLLECTION SHEET
REGENERATIVE BLOWER SYSTEM
SITE _____
EAKER AFB, ARKANSAS

Date	Time	Blower Functioning Upon Arrival? (Y/N)	Inlet Vacuum (inches H_2O)	Outlet Temperature (° F)	Outlet Pressure (inches H_2O)	Power Usage (kw-hr)	Comments	Checked by (initials)

c:\cbs\forms\BLOWER2.XLS